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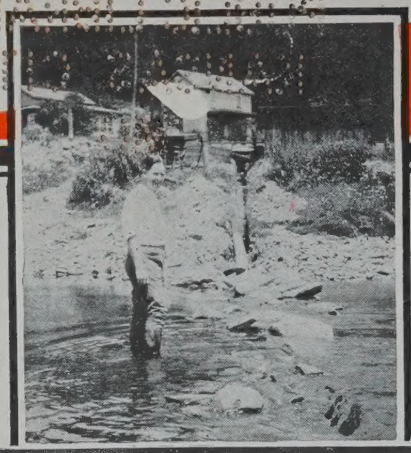

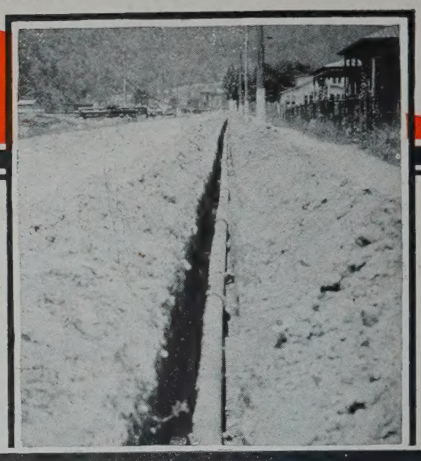

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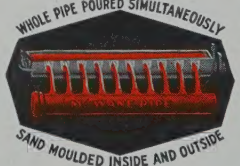

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Municipal News and Water Works

Design, Construction, Maintenance and Operation of Municipal Works

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Logic—A Challenge to Engineering Educators

Logic is taught in very few engineering colleges as a regular part of the courses. This seems to mean either that "the science of thinking" is not regarded by engineering educators as being a necessary part of an engineer's education or that it can be best acquired as a by-product of certain courses of study.

There is no doubt that pure and applied mathematics furnish excellent training in certain kinds of reasoning. But any one who has carefully investigated the subject of logic could scarcely fail to see that mathematics is insufficient as a training in logic. For example, mathematics does not discuss the use of language as a tool of reasoning. All books on logic stress this phase of the art of correct thinking, and whatever their weaknesses, their strength in this particular branch is undeniable. Indeed the syllogistic logic is little else than a sort of glorified grammar for thinkers. Lawyers receive an intensive training in the accurate use of language. Engineers, as a rule, do not receive such a training, and the resulting weakness is often very serious. Although the original object of language was to convey ideas (or, if you agree with that French philosopher, to conceal them), its main use to a thinker is to assist him in thinking correctly. Anyone who has studied algebra can appreciate the confusion and error that would occur if the symbol X were used to denote a velocity in the forepart of a demonstration and were carelessly changed later on to denote space traversed without regard to time. There are countless examples of just that sort of switch in the meaning of words used in discussions. Even worse, and much more common, is the failure to define important words. This is equivalent to assuming that the reader knows what you intend to signify by the letter X without your telling him. Curiously enough, if you are asked to define some important word, you will usually find that you can not do it off hand in such a manner as to stand any rigorous test.

Take, for example, the word conceive, and try to define it. Unless you have previously given a good deal of thought to its meaning you will almost surely fail to define it properly. Yet, it is a word that you probably use frequently. You speak of great distances, such as the distance to a star, as being inconceivable. Yet you do not hestitate to reason about such great distances by comparing them with one another, and with small distances. Do you admit, then, that you can reason about inconceivable things? If so, you can be easily run into a logical cul-de-sac. Then your only escape is by revising your statement of inconceivability, so that it amounts to this: A great number is not picturable at one glance, but may be conceived by successive additions (or multiplications) each of which is picturable. Conception, in other words is not necessarily a mental instantaneous picture but it may be a mental moving picture that involves a long time.

We have used this particular example because there have been many important scientific debates that have really hinged on the meaning of the word conceive, and in most of those debates not one of the debaters has seen that it was necessary to define the word conception.

We learn the meanings of most words by hearing them used in association with things and with other words that we already know. Hence all of us have acquired the sloppy habit of thinking that there is no need of carefully defining commonly used words. We take it for granted that we know their exact significance and that our hearers also know it. It is somewhat of a jolt to our confidence in this respect when we find that we can define relatively few words with exactitude. Just this sort of jolt is what we get when we study logic, and few of us ever get it otherwise.

Unfortunately most of the existing text books on logic devote only a single chapter to the subject of definition, and have little to say about research logic. On research logic or inductive logic as logicians have preferred to call it, Mill's discussion has been copied by other authors, almost slavishly, and it is an altogether unsatisfactory presentation of what should be the most valuable part of logic.

Doubtless it is the obvious defects of text books on logic that have served to turn engineering educators away from the study of it as a desirable part of an engineering course. But this very weakness should encourage professors of engineering to attempt to convert logic into the powerful educational instrument that it seems susceptible of becoming.

"Logic for Engineers," as several professors have remarked in correspondence with the editor, is about as poor a title for a book as "English for Engineers." English is English, and logic is logic. True, but the general treatises on logic have been so unsatisfactory to scientific men that some distinguishing title seems desirable for any new book that is to differ much from the Aristotelian syllogistic logic and Mill's inductive logic. Perhaps a better title may be "Research Logic"; at any rate the editor has in preparation a book that will bear that title.

All productive thinking calls for some amount of research on the part of the thinker, whether it be the thinking involved in designing a culvert or the thinking involved in the discovery of a law of nature. In every case there should come first the gathering of data that seem to bear upon the problem. During the process of data gathering, theories, new or old, should direct the classifying of the data, and the interpretation of their significance. New relationships may then be discovered, or old ones may be seen exemplified. Each problem, however small, becomes one of growing fascination, and takes on an importance that drives the investigator to do his best in solving it. Contrast such an attitude with the more common one of merely seeking some sort of a solution that will "get by." Contrast the method of thorough search for pertinent data with the more common one of presenting the engineering student with all the required data either in the

statement of the problem or in some handy reference book.

Existing text books on logic furnish little more than the barest hints on the gathering of data. Their authors seem to think either that this is not a teachable process or that every student has an instinct that will lead him in such searches. Yet data gathering, the editor finds, is by all odds the most difficult process that confronts the reasoning mind. That it can be taught is almost self-evident. That it is not ordinarily taught is well known. That no instinct leads the average man, or even the educated man, to become a thorough collector of pertinent data before drawing his final inferences, is a matter of such common knowledge that we need not dwell upon it. In fact science came into existence only after a few men, here and there, saw clearly the necessity of gathering and classifying facts relating to the properties of matter. Even yet the percentage of men who see this necessity is pitifully small. The rapidity of our whole future economic progress will depend mainly upon the rate at which this percentage will be increased.

The interpretation of data thus gathered is another branch of research logic, and one whose importance is scarcely less than the gathering of the data. Such interpretation takes the form of scientific theories. It is the editor's belief that there is more than "scientific intuition" involved in originating correct theories, and that methods of originating such theories can be taught. "Scientific intuition" itself may be nothing else than good method coupled with good memory; the former being teachable, the latter susceptible of being improved by training.

Magnetism vs. Gravitation As a Cause of Many Air Currents

Are barometric gradients the main causes of our cyclonic air currents, or are they the effects thereof? We do not recall ever having seen such a question in print before, yet we ask it in all seriousness. It has been taken for granted that all air currents on our globe are caused by the force of gravitation, somewhat modified at times by centrifugal force. The barometer registers differences in air pressure and all winds are supposed to be the result of such differences. While it is undeniable that many winds are merely convection currents, it may be that the major movements of air are electromagnetic phenomena.

Elsewhere in this issue it is shown that certain (perhaps all) cyclonic storms travel in parabolic paths. It will puzzle physicists to explain such a path on the theory of gravitative pressure and centrifugal force. Yet it is readily explainable on an electromagnetic hypothesis.

The cyclonic rotation of storms has been explained by the hypothesis that centrifugal force is stronger in the lower latitudes. But what becomes of this explanation when applied to a small whirlwind a few feet, or even a few inches, in diameter? Is a difference of a foot or so in latitude sufficient to account for one of those very intense though small dust whirls that are so often seen?

If the whirling motion of cyclonic storms finds unsatisfactory explanation in treatises on meteorology, even more unsatisfactory are the reasons given for the eastward trend of such storms. How does it happen that they travel faster than the earth rotates? Is it because they are carried along by upper air currents? Then why do the upper air currents move eastwardly? And why do cyclonic storms advancing in a series have velocities inversely proportional to their distance apart?

Cyclonic storms have centers of low pressure, and they are followed by anticyclones that have centers of high pressure. Why don't the "highs" flow into the "lows"? What conceivable arrangement of high and low pressure areas can cause a continuous eastward movement of both high and low pressure areas? How can the earth's rotation impart a continuous and greater eastward velocity to air than the earth's rotative velocity?

Our search for satisfactory answers to these questions has been fruitless. If you are weak in physics and strong in credence when authorities speak, you may find satisfaction in some of the answers, but if you insist on physical demonstration that carries conviction, you are certain to be disappointed.

Sunspots are cyclonic storms in the sun's atmosphere. They have many features that are strikingly like our cyclonic storms. Since meteorologists explain the latter as being the results of flow of cold polar air equatorward, we wonder how they would explain the former, sunspots. How would they explain the rotation of sunspots? Since sunspots move forward with exceeding slowness, centrifugal force could hardly account for their rotation.

Sunspots are powerful electromagnets, as Hale has shown. It is therefore probable that their rotation is an electromagnetic phenomenon. If so, analogy suggests that their first cousins, our cyclonic storms, are also electromagnetically rotated. We know that all air contains "free" electrons. We know that "free" electrons in motion constitute an electric current. We know that "free" electrons in rotary or orbital motion constitute an electromagnet. So we may infer with certitude that every one of our cyclonic storms is an electromagnet. What we do not yet know is their magnetic strength. But when we see them rotating and progressing in a manner that shows great power, we may infer that our cyclonic storms are whirling masses of ionized air that are powerfully electromagnetic, taken in the aggregate. This of course does not imply that a relatively small volume of such air will show great magnetic force. We should no more expect that than we should expect to find a powerful gravitative pull between two clouds.

If electromagnetic force rotates and propels the air of our cyclonic storms, and if periodic changes in the size and intensity of such storms account not merely for weather changes but for climatic changes, it follows that electromagnetism is fully as important a factor as convection currents. Indeed it seems to us to follow that convection is to be regarded as less important.

Finally, does it not seem probable that if air is rotated electromagnetically, the low pressure within such a rotating mass is a result of rotation? If so, it must follow that many important barometric gradients are the results of air currents, and not their cause.

W. P. Gillette

The Parabolic Path of Cyclonic Storms

By HALBERT P. GILLETTE

AS announced in a previous article, I believe that all cyclonic storms are rotated by the electromagnetic energy of the earth. Many storm phenomena are thus explained. That cyclonic storms are propelled eastward and toward the equator electromagnetically is a corollary of this electromagnetic whirl theory.

Being an electromagnet itself due to the presence of free electrons in the vortex of air, a cyclonic storm would be driven from the more intense parts of the earth's magnetic field to the less intense, or toward the equator. It would also be propelled laterally.

The resistance of the air results in a constant velocity of a storm in its eastward or latitudinal direction, just as a falling raindrop soon attains a constant velocity. But the force that propels the storm meridionally toward the equator has a negative increment, due to the opposite polarity of the two ends of the magnetic field of the earth, the resultant being zero at the magnetic equator.

Hence we have a phenomenon that resembles the movement of a jet of water ejected horizontally under a constant head. The constant horizontal velocity of the jet corresponds with the constant latitudinal velocity of the cyclonic storm. The steadily increasing vertical velocity of the jet corresponds with the steadily decreasing meridional velocity of the storm. Hence, since the path of a water jet is a parabola, that of a cyclonic storm should be a parabola, unless changed by other wind movement. As a matter of fact this is the case.

For example in Clayton's "World Weather," p. 125, there is shown the path of a cyclonic storm from Finland to Vladivostok, north of Korea. This storm center moved about 15 degrees south while travelling about 60 degrees east; and taking various coordinates along its path from Finland, its eastward distance of travel varied as the square of its southerly distance, showing the curve to a parabola.

This law of parabolic paths of cyclonic storms can be used to determine the point of origin of such storms, as well to forecast the path from known coordinates.

Clayton (p. 269) states, as an empirical law, that the velocity of a cyclonic storm center varies inversely as the "length of the solar cycle" of activity that caused the storm. He means (p. 267) that the velocity of a cyclonic storm varies inversely as the period of time between successive storm centers as they move in a periodic series.

Clayton gives no reason for this law, other than an analogy between the velocity of ocean waves and storm waves (p. 112) but the analogy, it seems to me fails to apply, for the velocity of ocean waves increases as the distance apart increases, whereas the converse is true of storm "waves."

Clayton (p. 203) thinks that cyclonic storms are carried eastward in temperate latitudes by the general eastward trend of the air. If so, why do cyclones not travel northeastward, in the northern hemisphere, instead of southeastward? The northeastward trend of the north temperate zone itself calls for explanation, and no satisfactory explanation is to be found in the heat convection theory. We have northeasterly equatorial trades in the same hemisphere that we have southwesterly temperate winds, so that we can not invoke the earth's centrifugal force to explain the one without running into difficulties over the other.

The fact is that the convection theory of cyclonic storms falls down at nearly every turn, and no amount of bolstering with other forces, such as centrifugal force, serves to keep it on its feet. On the other hand, the electromagnetic theory explains every characteristic of such storms; and, as above indicated, it explains some characteristics with mathematical precision.

Let us consider Clayton's law of reduced storm velocity when storm centers are farther apart. Convection yields not the slightest clue to such a law; but electromagnetism does. Since parallel electric currents attract one another, and since free electrons in air moving in mass constitute parallel electric currents, a rotating mass of air should tend to concentrate into a belt or ring of rotating air having a somewhat quiescent center. Moreover, the greater the velocity of rotation, the greater the tendency to such concentration. But the greater the concentration and the greater the velocity, the stronger the electromagnet. The stronger the electromagnet, the more rapidly it is propelled by any other magnet. Hence cyclonic storms of small diameter travel more rapidly because of the greater intensity of their electromagnetism, also because their small diameter reduces the friction of the quiescent air through which they travel.

The magnetic needle shows varying deflections during storms, but this has been regarded as a secondary phenomenon, resulting presumably from the static electricity caused by friction, whereas I regard such magnetic changes as being a primary phenomenon resulting from the motion of free electrons with the air currents.

It is not impossible that the whirling belt of air that constitutes a cyclonic storm may itself be rising but slowly if at all, and that the air that is ascending is the air within the whirling belt, where rarefication is caused by the flow of air toward the rotating belt. But I am inclined to think that electromagnetism plays a very important part in raising the current of ionized air.

Humphrey's "proof" that electricity can have little effect on air motion is based solely on consideration of the attraction of electrostatic charges. Hence it has no bearing whatever on air movements caused by electromagnetism, a phenomenon that he seems to have overlooked.

Cyclonic storms originate in high latitudes and travel eastward and toward the equator, dying out in lower latitudes. This phenomenon bears strong resemblance to sunspots, except that the velocity of sunspot travel is relatively slow. Perhaps this difference in velocity is explainable on the theory that the upper and lower fields of magnetism more nearly balance in their effect upon sunspots than is the case on the earth. Incidentally this theory may explain the periodic reversal of polarity of sunspots, discovered by Hale. It can be seen that sunspots (being electromagnets) must tend either to repel or attract the ionized atmosphere above them (which, through its rotation causes the upper magnetic field). Hence a predominance of sunspots of a given polarity would warp the upper magnetic field. It is easy to picture a consequent alternate up and down warping of the upper field, so as to cause the lower (and less movable field) to predominate in its magnetic effect when the upper field is warped to a higher elevation. This would cause a periodic alternation in the rotation of most of the sunspots in the sun's two hemispheres, exactly as Hale has found to be the case.

Sunspots are so closely analogous to our cyclonic storms that each may be used to explain the other, and thus lead to a much better understanding of both.

Record Fabricating Job.—A record fabricating job was recently executed on the apartment house structure covering the block front on Madison Ave. between 70th and 71st Sts, New York City. This was accomplished by the Hay Foundry & Iron Co. for the Tishman Realty & Construction Co. The building is 11 stories in height. The steel work represented the assemblying of 9,762 pieces of steel and the driving of 36,200 rivets in the field. The plot occupied by the building is 30,000 sq ft. Approximately 2,200 tons of steel were used. The steel work was started Sept. 17 and the erection of steel completed Oct. 11, 1928.

City Officials' Day at Cleveland Convention

Important Reports to Be Presented and Discussed

THE city officials' division of the American Road Builders Association will hold its first annual meeting on Jan. 15, during the 26th annual convention and road show of the association. The division was organized June 8, 1928. Its aim is the standardization of city street and highway construction, maintenance and operation, including traffic regulation. At the meeting on Jan. 15 the various standards committees will present their reports as outlined below—the result of the year's work in each particular field. The city officials present will have the opportunity to discuss the reports, bring out such points as may be involved in their own particular problems and receive the benefit of the personal contact and experience of others.

Program for City Officials' Day.—The program announced for the city officials' day includes the following:

"Trend of City Government," Wm. R. Hopkins, City Manager, Cleveland, Ohio.—A subject presented by the able manager of a progressive city, whose growth and advancement have been phenomenal. This is an opportunity to learn how it was done from a man who will speak authoritatively on this subject.

Report of Committee on Administration, Organization and Finance; Chairman, H. C. Whitehurst, Assistant to Engineer - Commissioner, Washington, D. C.—It is the aim of this Committee to present clearly and logically the methods of administrating and financing city highway work. The report is based on a survey of present practice in more than sixty cities, selected as typical examples. These sixty cities were selected after information had been collected from 326 cities in 46 states and the District of Columbia. The report is informative and will be used as the groundwork for the future activities of this important committee.

Report of Committee on Design and Construction; Chairman, Geo. B. Sowers, Deputy Commissioner, Division, Engineering and Construction, Cleveland, Ohio.—The message of this report will be the need of standardizing and adopting by cities best present construction methods. It will include the principal types—asphalt, bituminous concrete, cement concrete, brick and block pavements. Important discussions of these pavement types will follow the committee report, led by persons who have made national surveys of each. Contrary to general belief, construction methods vary greatly, as does the selection of type for a specific class of traffic. The conclusions of this report, which are based on the summarization of present practice, will be of immense practical value to those who attend this session.

Report of Sub-Committee on Sub-Grades, Foundations and Bases for Pavements; Chairman, C. A. Hogentogler, Senior Highway Engineer, Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.—The basic principles of success and failure in pavement foundations and subgrades will be discussed in this report, which is characterized by simplicity, directness and practical application. Few reliable sources of information have been overlooked by its author, who for many years has studied the perplexing problems of subgrade and foundation. To learn first hand the concise information contained in this report may mean the saving of thousands of dollars to those cities which can profit by the experiences of others.

Report of Committee on Maintenance; Chairman, C. E. Myers, Director of Transit, Philadelphia, Pa.—No subject is more important than maintenance. The report of this Committee, together with the selected discussions by city engineers of national prominence, will be of inestimable value to those who desire more information on the maintenance of city streets. Maintenance is an ever-present problem, which involves a wide variety of methods in modern practice. Some of these methods are good, others are better. A report on this subject, followed by open forum discussion, cannot fail to show those methods which have been found adequate through practical usage.

Report of Committee on Traffic; Chairman, M. O. Eldridge, Assistant Traffic Director, Washington, D. C.—The traffic problem is so serious that the United States Department of Commerce has codified recommended practice. This Committee report will present facts and conclusions which are drawn from the "Hoover Code" and other authentic sources of information. The importance of solving traffic problems is so vital to every city official that this report must be of unusual interest. The Chairman of this Committee, by his intimate contacts with the principal agencies which are attacking traffic problems, is especially qualified to present the situation. The conclusions of this report are not local in character, but embrace the entire United States. They will be of interest and usefulness to officials and manufacturers alike.

The Convention.—The 26th Annual Convention and Road Show of the American Road Builders Association which will be held Jan. 14-18 at Cleveland, O., will bring together the engineers and road builders from all over the United States and Canada, as well as from foreign countries, for the purpose of exchanging ideas on the most recent methods of highway construction, operation and maintenance. The program at the 1929 convention will consist of reports of committees identified with the several divisions, as well as reports and papers on subjects of general interest. These reports will constitute the year's work on the different subjects and will present the latest methods and standards.

The Road Show.—The exposition which is held in conjunction with the convention, is the largest demonstration of road-building machinery, materials and methods in the world. It makes available for personal inspection all the newest and most up-to-date equipment and materials used in the road-construction and maintenance field. Over 500 carloads of the latest developments in road building machinery, equipment and materials, comprising the world's largest road show, will be on exhibition at the Public Auditorium, Cleveland, O. The space available for the road show has been augmented by the addition of a new wing to the Public Auditorium and this building, together with the Central Armory, will make possible the display of a far greater number of exhibits than ever before—in all, there will be more than 200,000 sq. ft. of floor space occupied by exhibits of machinery, materials and equipment, the most complete and comprehensive exposition and demonstration of this type ever held at any time and any place.

The Convention will be officially opened by Colonel R. Keith Compton, President of the American Road Builders' Association. The delegates will be welcomed to Cleveland by the Mayor of that City, Honorable John D. Marshall.

Tuesday, as stated above, will be City Officials' Day; Wednesday will be County Highway Officials' Day and Thursday will be Pan American Day. On these days the various sessions of the convention will be devoted to the presentation of reports of committees, and papers and addresses, by engineers and officials prominent in the highway field. These reports and papers will deal with the construction, maintenance, operation and financing of roads and streets.

In addition to attending the meetings on Tuesday, city officials should not overlook the opportunities afforded at the sessions to be held on Wednesday and Thursday under the auspices of the Contractors, Engineers and Officials, County Highway Officials and Pan American divisions.

Asphalt Paving Methods Used in the City of Lancaster, Ohio

How New Pavement and Resurfacing are Handled

By WALTER W. GRAF
City Engineer, Lancaster, O.

THE slogan of the City Engineering Department of the city of Lancaster, O., is "Better Pavements Without Materially Increasing the Cost." In city paving work we are at a decided disadvantage when compared with state highway work on account of our many widths of streets, types of construction, manhole covers, valve boxes, existing improvements, street railway tracks, street intersections, different curb elevations and grades, etc.

Sub-Grading.—The first thing of importance in securing a good pavement is a uniform subgrade, which will insure us a uniform specified thickness of foundation and wearing surface. This can only be obtained by having the subgrade cut true and parallel to the wearing course. We are securing good results at a very small cost by making a light wooden template, cut to the contour of the street, with steel teeth set 2 ft. on centers across same so that the teeth will score the subgrade at its proper elevation when the template is resting on the curb and pulled along the street. This will cut the contractor's cost of fine grading, as no time is wasted in measuring and the most stupid workmen cannot go wrong. This not only cuts fine grading costs but insures a uniform thickness of foundation which is essential, as a foundation, like a chain, is no stronger than it weakest link.

The Base.—After the subgrade is cut to the proper contour and elevation, the next essential thing is to finish the concrete base parallel thereto. For finishing concrete base, we use a heavy wooden, steel shod, "strike off" template pulled by the mixer and follow this with a light wooden "tamping" template, cut to the contour of the street and operated by a man standing on each curb. This method will finish the base, with a few exceptions, without the use of hand floats. This method of finishing leaves a smooth surface which is roughened by the use of a wooden tamper 2 ft. in diameter with a coil of ⅝ in. cable attached so as to leave a print of the cable in the base. We find this to be a splendid method of preparing concrete base to receive sheet asphalt pavements. We believe that the more nearly perfect the contour of the concrete base the more nearly perfect will be the riding qualities of the finished asphalt surface. A perfect base not only gives the "rakers" a guide, but insures a uniform thickness of asphaltic wearing surface and therefore uniform compaction under the rollers. It has been hard to persuade either foreman or workman that a concrete foundation to be covered with asphalt, has any need to be true to contour. If there is a defect, "why not make it up in the binder," is the question asked. This leaves great variations in density and thickness with the resultant disagreeable waves in the surface. For these reasons, we check car concrete base with string lines at 8 ft. intervals behind the finishing template.

Pavement on First Court; 1 In. Binder, 1½ In. Top on 6 In. Concrete Base

Binder and Surface.—Where concrete base is finished as above specified, we find that more than 1 in. of binder is unnecessary and therefore always lay 1 in. binder on new work. On resurface work we find that it will require approximately an extra 100 lb. of binder to bring the old brick foundation up to the proper contour to receive a 1 in. binder. On resurface work, before any binder is laid we thoroughly clean the old brick street with water from a fire hose operating under a 100

Pavement on South Columbus St.; 1 In. Binder, 1½ In. Top Resurface Over Old Brick

lb. pressure. This not only cleans the foundation, but opens the interstices between the brick which insures perfect bond between the foundation and the binder. The binder course is inspected with a "straight edge" the same as the top and must show the same degree of smoothness. The top surface or wearing course, when laid must not vary from a 10 ft. straight edge more than ¼ in. This requirement, frequently and carefully checked by the inspector close behind the rakers, has the effect of creating a rivalry among these workmen and insures constant attention to one of the all important operations in the laying of a sheet asphalt pavement. With careful longitudinal raking and transverse luting with a 5 ft. wooden lute on a long handle followed by thorough longitudinal and cross rolling, this standard is not hard to attain and costs no more than work half done. Many otherwise well constructed pavements are condemned by the public on account of a rough surface. The citizenship judge a pavement by its surface smoothness and ease of riding.

For the past few years with the use of these simple and inexpensive methods, good washed sand and gravel, tested cement, stone, sand and asphalt, we have been able to sell the citizenship of Lancaster on asphalt streets where only six years ago the first asphalt pavement was laid. We have open specifications and have laid both oil and lake asphalts. For the past two years all asphalt streets in Lancaster have been laid by Brewer & Brewer Sons, Contractors, of Chillicothe, O., using Texaco asphalt.

Ohio Filtration Men Meet

The 8th annual meeting of operators, chemists and others interested in the filtration and water softening plants of Ohio, held at the Argonne Hotel, Lima, Nov. 1-2, drew a larger attendance than any previous conference, with about 100 registered. Practically all of the 58 filter plants and 21 water softening plants in the state were represented. In addition, representatives of several municipalities contemplating water supply improvements were present. After the meetings a visit was made to the Lima filtration plant and many also drove to Piqua to inspect the new water softening plant there.

Officials chosen for the coming year are: Chairman, C. T. Kaiser, Newark; vice-chairman, A. E. Hess, Alliance; secretary-treasurer, James M. Montgomery, Piqua. Other members of the executive committee are Frank S. Taylor of Defiance and J. H. Wenger of Westerville.

The conference favored Columbus for the 1929 session, but decision as to the place of meeting is left to the executive committee.

Short Courses for Sewage Plant Operators

Rutgers University, New Brunswick, N. J., is again offering short courses for sewage plant operators. These courses will be held Jan. 14-26 under the direction of the College of Engineering in co-operation with the New Jersey Sewage Works Association and the New Jersey State Board of Health.

This is the third consecutive year that these courses have been given and the attendance has been steadily increasing. The work of the courses is planned so that there is approximately 35 hours of laboratory work and 12 to 15 hours devoted to lectures and recitations. In addition there will be eight round-table discussions of various phases of plant operation.

Attendance to these courses has been largely from New Jersey although there have been many from outside states as far west as Ohio.

The purpose of the Rutgers Short Courses for Sewage Plant Operators is primarily to offer intensive training in the fundamentals of sewage disposal and sewage plant operation. It is an opportunity through which plant operators may better qualify themselves to solve their individual problems; to increase their general knowledge of sewage disposal and its relation to the public health and thereby enable them to discuss more intelligently, with the officers of their municipality the needs and necessary changes in their plants. Furthermore, it will afford opportunity for those men wishing to become operators, to qualify themselves to meet the requirements of the New Jersey State Board of Health for such positions.

The short courses will extend over a period of two weeks, beginning with registration on Monday, Jan. 14, and ending Friday afternoon, Jan. 25. Classes will be scheduled daily from 9 to 12 in the morning and from 1:30 to 4:30 in the afternoon and ending at noon on Saturday.

The courses are as follows:

Course I — Professor Lendall

Lectures and recitations—16 hours.

The elements of design and construction of different types of treatment plants—details of operation and maintenance.

Laboratory exercises—23 hours.

Prof. van der Meulen

Lectures and demonstrations by the instructor and actual determination and tests by the student. The work will cover the principles of chemistry as applied to sewage treatment, determination of solids, digestion of solids, hydrogen ion concentration, biochemical oxygen demand, sterilization and other phases of operation with which the operator is concerned.

Course II — Professor Lendall

Lectures and recitations—6 hours.

Comparison of the design of existing plants with operation data. This course is planned to show how details of design may be changed to improve operation and efficiency.

Laboratory—40 hours. Dr. Rudolfs

A continuation of Course I with more detailed study; the adjustment of the reaction of a tank by addition of lime, odors and their control, biochemical oxygen demand and Bacteriology. Some time will be given to water purification.

Course III—Sewage Plant Testing

Professor Lendall and Dr. Rudolfs

Lectures—6 hours. Laboratory—35 hours.

Methods for making extended tests on sewage plants. Sampling and preservation of samples. Analysis and interpretation. Measurement of stream flow and stream pollution.

The many problems of plant operation and design will be treated in informal discussions for which definite periods will be scheduled. These discussions will be led by men of experience and who are thoroughly acquainted with plant conditions in New Jersey and nearby states.

There are no educational requirements for admission to any of the courses.

Admission to Courses II and III will be based entirely on training and experience.

A nominal fee of $5 is charged for admission to any course.

Prof. H. N. Lendall is in charge of the courses and applications for enrollment may be obtained by addressing him at Rutgers University, New Brunswick, N. J.

Perils of British Streets

A deputation from the British National Safety First Association recently waited upon the minister of transport to ask for a full inquiry into the causes of street accidents, and to make suggestions with a view to reducing them, according to the London correspondent of The Journal of the American Medical Association.

"In 1922," the correspondent writes, "there were in Great Britain 2,728 fatal and 79,197 non-fatal accidents in the streets owing to vehicular movement. Last year the number rose to 5,329 fatal and 148,575 non-fatal. It is stated, however, that the rate is slackening in proportion to the number of motors and drivers licensed.

"Last year the vehicles most involved in fatal accidents were private cars and taxicabs, the proportion being 1,509, or more than a fourth of the whole. Motor vans and lorries, however, made a good second, with 1,104 fatalities. Motorcycles, which many regard as dangerous, were concerned in 784 fatal accidents. Motorbuses and coaches, which carry much of the heavy passenger traffic, figured in only 613, while horse-drawn vehicles were the cause of only 193.

"In London there were 293 street fatalities during the first three months of the current year, compared with 214 in the corresponding period last year. Excessive speed is declared to be the most fruitful cause of accident, though want of care or hesitation on the part of pedestrians is held to contribute to a great extent."

New York's First Printed Traffic Regulations.—New York's first printed traffic regulations were issued in 1903. Before that time the unwritten law of "keep to the right" was the only rule of the road.

How a Water Company Increases the Number of Its Customers

Mutual Benefit of Cooperation Between Utility and Plumbers

By NORMAN J. RADDER

AS a result of cooperation between the master plumbers of Indianapolis and the Indianapolis Water Co., more than 250 new customers have been added to the company's service list in the last six months.

For years Frank C. Jordan, Secretary of the Indianapolis Water Co., has had the idea that cooperation between the company and the plumbers would bring mutual benefits. He had some difficulty at first in making the plumbers see the point. Finally, however, they agreed to try it out.

Last spring, Mr. Jordan made out a list of the property owners in one section of the city who did not have running water in the home. In many cases they had a hydrant in the yard.

He turned this list over to G. T. Watson, Secretary of the Indianapolis Merchant Plumbers' Association, who worked up the list according to neighborhoods and then told his association members to get on the job.

They did and sold 250 complete bathroom outfits the average value of each being $250. Thus the plumbers made sales of $50,000 and the water company got 250 new customers.

In addition to giving plumbers the names of prospects, the water company has carried on an extensive advertising program in two of the Indianapolis daily papers and has also turned over much of its lobby space to a display of plumbing fixtures. These displays are installed by jobbers in Indianapolis and are changed frequently. Just recently Mr. Jordan called attention to the fact that more of the lobby space should be used for this purpose.

"I have to keep after the dealers all the time to keep leaflets descriptive of the equipment here to be picked up by the 50,000 customers who pass through the lobby each month to pay their water bills," says Mr. Jordan. "The people who came here are the best possible prospects for additional plumbing fixtures. We are glad to give the plumbers the opportunity to put equipment in the lobby, because if it helps them it gradually gets around to help us. We are anxious to sell more equipment to the home owner who has only a kitchen sink."

One corner of the lobby of the office of the Water Company has a most attractive display of a complete bathroom in a delicate shade of lavender with chromium fittings. A recessed tub is in the corner with a pedestal lavatory on one side and a toilet on the other.

Bathroom Equipment on Display in Lobby of Indianapolis Water Co.

View of Portion of Lobby of Indianapolis Water Co.

There is an attractive tile background. In another part of the lobby is a pedestal lavatory in a soft yellow shade, while across the lobby is a wall hung lavatory in green hung to a standard than can be moved around the room.

Mr. Jordan conceived the idea years ago that plumbers ought to sell equipment on the partial payment plan. It was only within the last year that he obtained general acceptance of the idea. No doubt it was the fact that plumbing equipment could be obtained on easy time payment that enabled plumbers to sell 250 bathroom outfits.

A few years ago, the Public Utilities Commission authorized the local water company to install meters in every building in the city of Indianapolis and they have been gradually enforcing this rule. Recently the water company decided to take different sections of the city and notify every user in that district that it was compulsory to install meters by a certain date.

Mr. Jordan, realizing the possibilities that such a situation offered to the plumbers, called in the officials of the Master Plumbers' Association, and together outlined a plan whereby a duplicate of a certain number of the notices sent out was given to the plumbers in the different districts with the understanding that it was not just for the small job of making the meter connection, but for the opportunity of selling these people some more plumbing work and especially the opportunity of being in the home and able to see what these prospects really needed.

The advertisements which the water company runs in the Indianapolis papers are educational and talk about the modernizing of property with sanitary plumbing, a higher standard of living, running water in the home, etc. They all end with the phrase "Consult your plumber" and point out that Indianapolis plumbers will sell fixtures on the partial payment plan.

Baltimore's Pier System Worthwhile Revenue Producer

Baltimore's great system of piers, known as Nos. 1, 2, 3, 4, 5 and 6 Pratt Street, are producing a worthwhile revenue, according to the Municipal Journal.

Under the supervision of the City Comptroller the city leases space on these piers at 42 cents a square foot per year. The total surface of the combined piers is 1,185,379 sq. ft. The combined length of all these piers, if placed end to end, would be 6,888 ft.

Prior to the great fire of 1904 the city owned but little wharf property of importance. The fire made it possible to acquire all of the burnt district fronting on the harbor (about 4,000 linear feet), and under the Six Million Dollar Loan the city purchased the property and removed all buildings streets, etc., and laid out a system of public wharves and docks south from Pratt Street, which has been made 120 ft. wide, with many streets running into same, also widened and improved. The public wharves and docks situated in the upper harbor are intended for coastwise, bay trade and market boats. The market boats come in at Pier No. 4, Pratt Street, or Long Dock, as it is commonly known, which is at the foot of Market Place and within a stone's throw of the Wholesale and Fish Markets.

Tenants occupy most of the space on these piers, but that part which is not leased is used for storage purposes for lumber, etc. In one year the wholesale lumber merchants handled over 70,000,000 ft. of lumber on the Municipal Piers and paid the city about $75,000 for this privilege alone.

Service Connections

Placed in Advance of Street Improvements

SOME interesting information regarding the experiences of Indiana cities in constructing service connections before a permanent pavement is laid, was brought out at a meeting last spring at the Indiana Section of the American Water Works Association. The notes following are taken from the November Journal of the Association.

Muncie.—We have not been very successful in our city in having the cooperation of the board of public works in helping us to complete service connections before permanent paving is done. Where it is necessary, we put these services in and try to collect from the property owner. In most cases we can collect, but there are a good many cases where we cannot. Where we collect from the property owner we put an account in our ledger and keep under this account the costs of the material, labor, etc., as a credit on our ledger. When the service is put in he is permitted to use that much water before he is made any charge. That seems to be the only way we can do it, but it is awfully difficult to do. The connections must be put in before the streets are paved and if the property owner does not pay it, it is handled as a lien and collected just as any other lien is collected.

Evansville.—We install services and charge the immediate property owner for these services. If they do not pay it, we add it to the tax assessments.

Kokomo.—We have a city ordinance providing if the city is to put in the paving we make a survey and furnish the city engineer and contractor who has the work a list of the lot numbers and sizes of service we think should go to the lot. This amount of money is added to the assessment roll. The contractor advances the money to us before he starts to work. The contractor pays us for the estimated amount of services and this is added to the assessment. When the service is used we refund to the consumer. We collect for ½ in. service, $25.00 and for ¾ in. $32.00. We carry these funds under an account listed as "Service Deposit" in the ledger, we can take off a trial balance at any time.

Evansville.—On non-improved streets we charge $10.00 for the service. This amount is charged to the contractor who puts in the street. He takes it over to the county or city clerk who takes it to the Board of Works. They add a charge of $1.00 to the charge we made and add it to the assessment roll. The charge then corresponds with our books.

Do you refund that to the consumer when he takes service?

Evansville. — No. For improved streets we charge $25.00, brick streets $15.00 and for unimproved dirt streets, $15.00.

Richmond.—For a number of years through the cooperation of the Board of Works, when a permanent improvement is to be made, the city engineer notifies the property owner that gas, sewer, and water must be installed. He indicates where the water taps are to be made and notifies the water company where the services are to be located. The record is sent to the Board of Works, added to the list of assessments of the property owners, in the city treasurer's account, and the water company is reimbursed for the actual cost of services. The water company has to lay all services to the curb, except in this case. After the owner makes application for water, the company refunds the cost of those services to the curb. There is no revenue until the service becomes revenue-producing. We refund the actual cost at the time it is put into service.

Evansville.—When you figure actual expense of refunding you are figuring overhead in general office, etc. Can you figure overhead in ledger and journal entries and construction? I do not see how you can figure insurance and time of making ledger entries, etc.

Richmond.—We add 10 per cent to the cost.

Lafayette.—We have an ordinance to cover this matter. We proceed in this manner: We require on applications for water the advance sum of $30.00. This $30.00 becomes a rebate in water rent until it is used up. We proceed in this manner on hard surfaced streets. We place the regular ⅝ in. service to the edge of the lot. We notify that the service has been put in. We give a description of the service and when the property becomes a consumer, they get credit for water rent to the amount of $30.00. We get along very nicely. Most of them are glad to know they have water when they come to sell the lot. If it is not paid we certify it to the Board of Works and in that way to the city treasurer, showing a lien on this property. It becomes a refund in watre rent later if it is not put in use for ten or twenty years. We could charge 6 per cent on these deferred payments, but we have not carried this out yet. The Acts of 1927 require platted ground to put in these services.

Evansville.—We charge $10.00 a service for unimproved dirt streets, $15.00 brick improvement, and $25.00 for asphalt before these services are installed. We do the best we can. We send postal cards, as a great many of these people live out of town.

Lafayette.—We do not call it charge; an advance is what it really is. We send a letter stating that it is payable by a certain time. If they fail to pay it, we certify it to the Board of Works, Controller and City Treasurer. When they come to pay the taxes the Treasurer informs them that water has been put in and that we require the payment of $30.00 from each applicant. We go ahead and do this and notify the owner it has been done. Very few unpaid services are put in on account of the hard paved streets.

Evansville.—If you would make a charge of so much to each property owner regardless of whether on the near or far side of the street for each service installed on the property, you would eliminate a great deal of trouble.

Richmond.—A uniform charge would be very desirable. That matter was taken up before the Commission. It seemed fair to make the same charge to the property owner on either side of the street. They said, "No." They said "you must make it the actual cost. The short side of the street has the advantage."

Evansville.—It would hardly be fair, if you spent $8.00 for a short service, to charge $18.00. I think you should bear that cost. If you buy a lot, you do not go down to the Board of Works to find out on which side of the street, far or near, the gas or water main is. Why should not the owners on either side of the street pay the same price?

Columbia City.—We are going ahead and making service taps, putting in the work and material at cost. We give the property owner 30 to 60 days to pay. We have never had any trouble in collecting our accounts. We make no refund whatever. It is a publicly owned plant. The property owner takes care of his service from the main to the curb and into the house. Everything is satisfactory. The water company, municipal or private, should run the service to the curb free to the consumer. They would have to rebate to every consumer from the main line to the curb, the cost of the labor and material. Of course, it is more on the long side of the street for labor and material. We do not aim to make any profit. We charge just what it costs. If we pay labor 40 ct. an hour, we charge the consumer 40 ct. an hour, and material the same. We keep that cost down as low as possible and we have no trouble.

Richmond.—Our company does not consider the 10 per cent profit. The 10 per cent is to cover insurance, superintendence, and legitimate additions to the cost. It is not a profit. It is incidental and intangible.

City Swimming Pools of Baltimore, Md.

According to a recently issued report of the Board of Park Commissioners of Baltimore, Md., the average yearly receipts of the Municipal swimming pools for the period of 1918-1928 amounted to $29,830. The investment in swimming pools is $900,000, not including the recently opened bathing beach at Fort Smallwood Park. The total number of patrons in 1928 was 498,665 and the average daily attendance at six pools was 6,472. The average daily cost of operation of the pools was $419.77 and the average daily reecipts were $567.86.

What's the Construction Outlook in the Municipal Field for 1929

Symposium of Opinions from Consulting Engineers Indicate an Active Season

Municipal Bridges for 1929

THE coming year promises to be one of unusual activity in the field of municipal bridges. The continued growth in motor vehicle traffic is rendering existing crossing facilities inadequate, and new bridges are being demanded to supersede ferries or to supplement existing spans. The newer structures are generally of larger magnitude to meet the requirements of greater traffic capacity and more generous navigation clearances. In many instances municipalities are now demanding long-span high-level bridges where low-level movable spans have heretofore prevailed; the desire to avoid traffic interruptions and delays, rather than maritime requirements, is the governing motive. Individual bridges of today represent much larger investments than those of the past. Everything in this field of construction is now being done on a larger scale. The recent rapid development of privately built toll bridges to meet the needs of vehicular traffic has apparently stimulated municipal interest and activity in bridge construction. The entire nation has become "bridge-minded."

In all parts of the country, cities and counties are voting large bond issues or are otherwise projecting bridge undertakings of magnitude. In the Northwest, large bridges have been voted or are being promoted in Portland, Seattle, and Tacoma. San Francisco is seeking authority to build a structure of unusual magnitude across the bay to Oakland or Alameda. In the Middle West, large municipal bridge projects are in various stages of advancement in Louisville, Cleveland and Toledo. In the East, municipal bridge projects of magnitude are under study or construction at New York, Providence, Norfolk, Knoxville, and Albany.

In the newer bridges planned for municipalities, more consideration is being paid to artistic development of the design. The technical problems of stresses and strains have long ago been surmounted, and the designers are freer to devote their attention to studies of form and proportions. Pleasing appearance is sought, not by extraneous embellishments but by development of the most effective lines and harmonious proportions in the essential elements of the structure.

American cities are now voting many millions of dollars annually for new bridges. These are being planned on the basis of comprehensive city planning studies and traffic surveys. They are being built to afford needed traffic outlets, to by-pass and relieve congestion, and to develop new areas of population or industry. The public takes a wholesome interest and pride in each project as an expression of the spirit of enterprise and achievement of the community.

ROBINSON & STEINMAN,
117 Liberty Street,
New York, N. Y.

Prospects Bright in Chicago District

Prospects for municipal construction under our supervision for 1929 are healthy. Underground improvements probably will approximate the 1928 volume; while that of paving and street lighting may exceed it. Our 1929 construction in the Chicago Metropolitan district will probably reach $5,000,000; in the Kentucky district $1,000,000; in the Central Wisconsin district, $1,000,000 and in the St. Louis district $1,500,000. A large portion of the work in the Chicago, St. Louis and Central Wisconsin districts consist of water filtration and sewage disposal plants.

CONSOER, OLDER & QUINLAN,
205 West Wacker Drive,
Chicago, Illinois.

Future Prospects Attractive in New York

The prospect for engineering work in the municipal field for 1929 appears unusually attractive. The writer as consulting engineer in conjunction with Whitman, Requardt & Smith, Engineers, is engaged in the construction of a new gravity water supply system for the city of Albany, at an estimated cost of about $9,000,000. The village of Herkimer, N. Y., has just let contract for the construction of a new gravity water supply, from plans prepared by the writer some years ago.

Various other projects are in hand or appearing on the horizon and the indications are that continued prosperity and industrial growth will demand and provide the necessary means for municipal improvements, particularly in connection with water supply and sewage disposal.

ROBERT E. HORTON,
Voorheesville,
Albany County, N. Y.

Expects Sanitary Refuse Disposal Projects

The prospectus of work in the municipal field seems fairly bright in northern New Jersey. The rapid progress of the construction of the Hudson River bridge has indeed hastened the highway building program in Bergen and adjoining counties. Scientifically planned developments like the "Motorage" city of Radburn, between Hackensack and Paterson, progressive townships Teaneck, Englewood, etc., are bound to keep pace with the rapid growth of the communities as far as sewer and street programs are concerned. There is all reason to believe that Teterboro and other airports will see vast improvements in the course of the coming year.

The Bergen County Chamber of Commerce, local chambers, businessmen's associations, service clubs and civic bodies are keenly interested in these questions as well as in the development of a state wide park system.

I have done, personally, a good bit of missionary work during the last few years spreading the gospel of sanitary refuse collection and disposal in properly designed and operated incinerators. Various communities of this district are talking incinerators, several have appropriations and it is to be hoped that the new year will see several incinerator projects materialize.

JOHN H. LIEBAU, R. A.,
328 Main St.,
Hackensack, N. J.

Big Improvements in Offing

A great many projects of magnitude, particularly with reference to sewerage systems, sewage treatment works, water works, and extensive drainage programs, have been investigated, reported on, and designed during the past year.

While there is a difference of opinion concerning the effect of a presidential year on business generally, I am convinced that engineering projects proposed for execution under political or semi-political direction have been effected. In some cases the contracts are awarded for whatever may appear advantageous to the public. In other instances a retarding effect is produced; presumably with the thought that agitation for or against might be considered detrimental to public policy.

In reviewing my practice and taking into consideration the prepared data on

extensive engineering works, I can, without any great degree of optimism, predict that the coming year will see an active construction program started. Many changes are taking place in the Metropolitan zone and huge engineering undertakings are under way. The compelling factor expediting these huge projects is—dire necessary.

Many of the contracts with which I am intimately associated are waiting the starting or completion of bridges, tunnels, and transportation facilities; and, reflecting on the development of the past year, it appears that 1929 will usher in an awakening for many of the apparently dormant projects.

THOMAS F. BOWE,
110 Williams St.,
New York City.

Prospects Bright for Hydraulic Construction

The outlook for 1929 is very encouraging in view of the fact that we have, as a nucleus, at the present time the completion of the plans and specifications for an additional water works station for the City of Erie to include an intake line from the lake, a low service pumping station, a filtration plant, a high service pumping station and connecting force mains designed for an ultimate capacity of 48 million gallons per day, of which 16 million gallons will be installed in 1929 at a cost of approximately $1,500,000. This will give the City of Erie, upon completion of these works, a total capacity of 48 million gallons per day, and ultimately 80 m. g. d. In addition to the water works, a sewage disposal plant has been designed for the City of Erie, the construction of which will proceed early in 1929. This plant was designed for a capacity of 40 million gallons per day. The project will include also the main interceptor leading to the sewage disposal plant and the construction of an open concrete channel for Mill Creek which will be straightened out through the site of the sewage disposal plant. The great majority of the intercepting sewers and overflow works was completed recently from plans prepared in this office. The cost of the interceptors, so far completed, has been in excess of $1,000,000.

Nineteen twenty-nine will see the completion of an extensive and comprehensive program of water works development designed by this firm for the City of Nashville, Tenn., when the 28 m. g. d. filtration plant of the city will go into operation. Likewise, the new water works of the City of Bowling Green, Kentucky and sewage disposal plant and sewerage system involving more than 20 miles of sewers for the City of New Lexington, Ohio; the softening plant at Fostoria; the sewage disposal plant for the Torrance State Hospital at Torrance, Pa.; the new water works and softening plant of the Borough of Sewickley; additions to the water works and electric power plant of the Borough of Etna, Pa.; the concrete arch impounding dam of the City of Norton, Virginia, and the reservoir improvements at Newport, Kentucky, will be completed in 1929. A new pumping station and filtration plant for the City of Lockport, N. Y., costing approximately $500,000, will be started early in 1929 as contracts for this work have already been let. Contracts for a garbage incinerating plant and substantial additions to the sewage disposal plant of the City of Greenville, Pa., will be let early in 1929 from plans already completed.

In addition to the above there are a number of other projects, one of considerable size and the rest somewhat smaller, which are in the course of preliminary studies and it is possible that the greater portion of this work will proceed to construction in 1929.

In general, the outlook for 1929 in our field and in general municipal improvements, such as roads, bridges, public institutions, etc., is very promising and we are rather optimistic.

THE J. N. CHESTER ENGINEERS,
Clark Building,
Pittsburgh, Pa.

Outlook for Municipal Construction Work

Due to a general slump of business in 1927, the percentage of taxes collected in the smaller municipalities surrounding Detroit was quite small. As a consequence the amount of municipal construction was smaller than usual, however, factories have been running full blast in 1928 and the tax payer has more money and will be more inclined to request improvements for 1929.

It is my belief therefore that there will be a considerable volume of sewer and water construction done in those villages that require such improvements with an increase in the amount of paving laid where sewers and water have already been installed.

HARRY L. HUDSON,
Broadway Exchange Bldg.,
Detroit, Mich.

Ohio District Has Good Outlook

The outlook for work in the municipal field for 1929 in this section of the country looks to be very good.

Many Ohio municipalities voted favorably on bond issues at the past November election and considerable work in the sewerage and water works fields undoubtedly will be started this coming year.

H. P. JONES & COMPANY,
1601-8 Second National Bank Bldg.,
Toledo, Ohio.

Parkway Improvements Along Hudson

In Westchester County, New York, several important projects under construction will be completed, work on new ones started and important projects for the future developed during the year 1929. Some of these in the eastern section of the county are the new Saw Mill River parkway, Cross County parkway, repavement and improvement of existing highways and streets and elimination of railroad grade crossings. New projects for which surveys, plans and financing are to be developed are the Hudson Riverside driveway, sewers and disposal plants.

The Westchester County Parkway Commission's construction program for 1929 includes the Saw Mill River parkway and the Cross County parkway. The Saw Mill River parkway is in a valley about a mile from and parallel to the Hudson River, and to extend from Yonkers about 7.5 miles northward to Elmsford; it will handle considerable north and south traffic of this section of the county. This is to be opened to traffic as far as Ardsley in the fall of 1929. Most of the grading, drainage and bridges have been completed, the remaining work consists of paving a 40-ft. driveway, landscape, grading, planting, lighting and paths from Tuckahoe Road, Yonkers, through Hastings-on-Hudson to Ardsley a distance of 4.1 miles at an estimated cost of $896,000, and grading, drainage and bridges for a continuation of the driveway from Ardsley to Elmsford a distance of 3.4 miles at an estimated cost of $594,000. The Cross County parkway work will include grading, drainage and bridges from Valentine Avenue, Yonkers, eastward to the recently opened Hutchinson River Parkway at California Park, a distance of 4.1 miles at an estimated cost of $1,692,000.

The Ravensdale-Jackson Avenue improvement in Hastings-on-Hudson and the Town of Greenburgh will be started in the spring. The work will include the elimination of the railroad grade crossing of the New York Central Railroad, Putnam Division at Ravensdale Road and the repaving and improvement of Ravensdale road and Jackson Avenue from Farragut Avenue eastward, across Saw Mill River parkway to Central Avenue. This is a cross county highway the improvement of which is essential for the execution of prospective local developments and needed in this part of the county. The grade crossing elimination is to be completed by the fall which will permit progress to be made upon the county improvement of the highway.

Warburton Avenue-Broadway improvement in Hastings-on-Hudson. Warburton Avenue is west of and parallel to Broadway, connecting to Broadway at the northern end and

when improved will relieve traffic congestion of Broadway. It is more direct with fewer hills and affords attractive views of the Hudson River for miles and of the Palisades on the opposite of the river. The survey has been made and repaving work is to begin in the spring starting at the Yonkers line. The type of pavement is to be decided by joint conference of village and county authorities.

The proposed Hudson Riverside driveway has been surveyed from Van Cortlandt Park, New York, to Kingsland Point and the Westchester County Board of Supervisors announced an estimated cost of the project as $34,000,000. The communities along the Hudson are endorsing this project and endeavoring to arrive at a solution of the financial problem. State aid has been discussed for the financing, being a large amount for the county to handle and the highway would be more of the nature of a state highway.

In the villages of Dobbs Ferry and Hastings extensive programs of street improvements have been carried out through 1928 and will be continued in 1929. Problems confronting the municipalities in the eastern area of the county are the early solution of the matters of sewers and disposal plants. With the continuously increasing population the present sewer systems will soon become inadequate necessitating intelligent planning now, for the immediate as well as distant future. A trunk sewer in the Saw Mill River valley, a disposal plant in the vicinity of Yonkers and an incinerator in the Town of Greenburg are projects for which plans and financing are being considered. The elimination of all telegraph and lighing poles from the main streets of Dobbs Ferry and other villages is contemplated also improvement in illumination and ornamental street lighting fixtures, including Dobbs Ferry and Hastings-on-Hudson. The Edwin Gould playground in Dobbs Ferry will be completed in 1929.

The crossing of parkways and highways with intersecting thoroughfares are generally planned and constructed on new developments to avoid crossings on the same grade by means of bridges and tunnels, as a permanent means of facilitating traffic and insuring safety at a minimum of maintenance cost. However some existing parkways and highways and also new projects have crossings at same grade which might have been easily avoided originally and plans may be developed for the elimination of some of these highway grade crossings. These grade crossings retard speed of traffic, require maintenance and operation of traffic control signals and constant supervision of traffic officers and, notwithstanding precautions for safety, they are a continuous hazard. Who should stand the expense of the maintenance of traffic control at such crossings is a frequent controversy. More attention and effort to avoid and eliminate highway grade crossings as well as railroad grade crossings should be made. This can be accomplished during original planning and construction with less expense than after completion of construction.

There are several railroad grade crossings of the New York Central Railroad, Putnam Division, in the Saw Mill River valley. Some of these are to be eliminated and the elimination of others have been considered. A bridge over the tracks at Nepperhan Road, Yonkers, is under construction eliminating this grade crossing and is to be completed in the spring and the bridge at Ravensdale to be completed in the fall will eliminate that one. It is expected that plans for elimination at other places will be consummated to remove the constant menace of such crossings.

Highway construction work in Westchester County will amount to about $8,000,000. In 1929 practically all projects of which have been officially approved; this includes State, County and Town work. Eight railroad grade crossings are included in the 1929 program and the construction cost of these structures may be about $2,000,000.

H. W. SCHARF,
83 Cliff St.,
Hastings-on-Hudson, N. Y.

Buffalo Vicinity to Compare Favorably with 1928

Street paving for the coming year, of which the largest percentage will be sheet asphalt on concrete base, will about equal that of 1928. The completion of bridges over Buffalo River and Cazenovia Creek will open the important thoroughfare of Bailey Ave. to traffic for its entire length. Just outside of the city line, the construction of a few short gaps of road will complete the outer loop of the Greater Motorways System, providing a detour to points south, east and north of the city without entering the city at any point. The new Southwestern Boulevard, about thirty miles long, will be about half finished. This is a 40-ft. road over entirely new right of way and parallels the present Lake Shore Highway about two miles south. Where it crosses Eighteen Mile Creek, the largest concrete arch highway bridge in this part of the state is being built.

Half a mile of Outer Harbor concrete dock wall is planned, which will enable the city to finish the grading for a large waterfront park. The remaining six hundred feet of concrete bulkhead required to complete the Niagara River side of Bird Island pier also is scheduled for construction. Dredging of Erie Basin will continue.

The fourteen hundred feet of Cornelius Creek drain, a 7 ft. x 10 ft. reinforced concrete overflow sewer, will be finished. Preliminary studies for a sewage disposal system for the entire city are well under way.

The new $14,000,000 Curtiss Street passenger terminal of the New York Central Railroad will be ready to use about May 1st. Plans for the new downtown passenger station of the same railroad will be ready so that work on this project should start soon after the Curtiss Street station is opened. Under the jurisdiction of the Grade Crossing and Terminal Commission, work on the Amherst-Austin Street grade crossing elimination, at a cost of about $3,000,000 will be started in a short time.

Bids will be called for on the new $6,000,000 city hall early in 1929 and work on the new State Teachers' College buildings and the state office building will also start early in the coming year.

CUTHBERT E. REEVES,
Liberty Bank Bldg.,
Buffalo, N. Y.

Expect Average Year

It is extremely difficult to make a reasonable estimate of the outlook for municipal engineering work likely to be undertaken in 1929 other than that handled directly by city engineers. From present indications, however, it is our impression that the amount of work which we are likely to handle will approximate the average of the past 4 or 5 years. It does not appear likely that there will be abnormal activity nor that there will be an especially small amount of work to be handled. It is our impression that 1929 may probably be expected to be an average year.

METCALF & EDDY,
Statler Bldg.,
Boston, Mass.

Southern District Prospects Optimistic

The indications are that there will be more than an average amount of municipal work such as waterworks, sewers, sewage disposal plants and street paving, in Oklahoma and Texas in 1929. A great many municipalities have mapped out programs for these improvements for which bonds should be voted or funds provided early in the year. It is our opinion that 1929 will show greater progress than this year.

BENHAM ENGINEERING CO.,
Perrine Building,
Oklahoma City, Okla.

Predicts Good Year in 1929

Indications are that 1929 will be a good construction year in water works and sewerage projects.

BARKER & WHEELER,
36 State Street,
Albany, N. Y.

Hydraulic Construction Expected to Be Active

Judging from work under way in our office, which is likely to go into construction the coming year, we are of the opinion that water supply, sewerage and sewage disposal for 1929 will be very active.

More large projects are now in prospect for starting construction next year than in any prior year. Construction prices apparently will be somewhat higher than in the last year or two.

As we specialize mainly in water supply, sewerage, sewage disposal and flood relief, we are only competent to express our opinion along those lines and those we believe will be active.

ALVORD, BURDICK & HOWSON,
8 So. Dearborn St.,
Chicago, Ill.

Immediate Prospects Not So Good

There does not appear to be a great deal of work in immediate prospect, but for municipal work there is needed construction in connection both with the city sewage system and its water works, the water works being more in the nature of extensions rather than improvements to filter plants and pumping stations. Also, it is expected that work will be started during the coming year on a bridge across the Delaware River connecting Burlington and Bristol, but this is a private enterprise though it involves street changes as well as the construction of the bridge itself.

CONRAD & BUSBY,
321 High Street,
Burlington, N. J.

Considers Prospects Good

An examination of the prospects in the municipal field, for engineering construction, seems to indicate that 1929 should prove a good average year. The slump in real estate activities together with a weak market for municipal bonds during 1928 resulted in the postponement and withdrawal of a considerable volume of work. National and local elections also have had their effect. However, with the election over and general business in excellent condition in the Chicago district, we are looking forward to an increase over last year's business.

KELKER, DE LEUW & CO.,
11 West Washington St.,
Chicago, Ill.

Patzig Expects Greater Activity

Municipal work in this territory for 1929 at this particular time looks normal. It has repeatedly been our experience that judging future conditions at this time of the year is difficult to do. Present rumors, however, indicate a little greater activity towards municipal construction than they did a year ago. Our business and agricultural conditions are better, so one feels justified in expecting a greater amount of construction work.

PATZIG TESTING LABORATORIES,
210 Eleventh St., Des Moines, Ia.

Mulholland Retires

Editorial in Nov. 15 Los Angeles Times.

Los Angeles owes more to William Mulholland, whose retirement as chief engineer of the Water Bureau has just been announced, than to any other one individual who has ever been associated with its service. For fifty years continuously he has labored to perfect the Los Angeles water system, and for twenty-six years has been its chief engineer. He will be long remembered as the builder of the Los Angeles Aqueduct, the boldest and most spectacular engineering work ever attempted by an American city, as well as one of the most difficult.

During his term of service the Los Angeles water system from a few miles of pipes valued at most at $100,000 has grown to a system of 3,200 miles of conduit worth at least $100,000,000, and supplying 285,000 homes, buildings and factories over an area of 440 square miles. The tribute paid to him by Commissioner Del Valle may well be quoted in part:

"He has ever regarded the duty of keeping the people supplied with water as sacred and inviolable. Many a time has this city been saved from actual shortage by the sleepless vigilance of this one man. Domestic use has been maintained; municipal needs have been met, and the public health, dependent at all times upon a pure and potable water supply, has been conserved.

"It may be asserted without fear of successful contradiction that no engineering achievement in this country within the past half-century has exceeded in difficulty or merit that of William Mulholland in keeping the water supply of this city, in its rapid growth and development, up to the requirements of its inhabitants.

"Despite his years and long service, he is still a vigorous and outstanding figure in the community, strong in the affection and esteem of his fellow-citizens. No ill fortune has been sufficient to shake the confidence of the people in this good and faithful servant."

Mr. Mulholland leaves office upon the eve of a still more difficult and costly achievement, the Colorado River aqueduct, but not without having laid a firm foundation upon which his successors can build. The preliminary planning of this great enterprise has been done under his watchful eye, and the city has in his probable successor, Assistant Chief Engineer Van Norman, a man of proved capacity upon whom it may rely to solve the further problems that will arise. Van Norman has had twenty years of service in the Water Department and was a division chief in the aqueduct work. Loaned to the city a few years ago to construct the outfall sewer, he built it in record time and at a saving of $5,000,000 from its estimated cost.

So that if the city suffers the loss of a tried and trusted adviser in Mr. Mulholland's retireemnt, at least he leaves to take up his work a man trained in his own school of rugged honesty and spirit of service to the community. The Water Department has, it is understood, a tentative plan of retaining Mr. Mulholland in an advisory capacity, and it is to be hoped that he can be persuaded to accept such a relationship.

It is difficult to imagine the Water Department without William Mulholland.

Transactions of the Eighth Annual Conference of State Sanitary Engineers, 1927

Public Health Bulletin No. 183, recently released, contains the transactions of the Eighth Annual Conference of State Sanitary Engineers. A number of committee reports in this publication are of general interest. The report of the Joint Committee of the Conference and the American Public Health Association setting forth the final standards for swimming pools and bathing places will have widespread application and should prove to be very helpful to all persons interested in the design, operation, and sanitation of swimming pools. The report of the committee on sewage treatment gives an interesting résumé of the progress being made in Ohio to obtain careful and scientific operation of sewage-treatment plants.

New England City Managers Organize Association.—City managers of Connecticut, Maine, Massachusetts, and Vermont have organized the New England City Managers' Association, to be composed of city and town managers in those four states. The following officers were elected at the first meeting:

President — C. A. Bingham, city manager, Norwood, Massachusetts, and formerly manager of West Palm Beach, Florida.

Vice-president—James E. Barlowe, city manager, Portland, Maine.

Secretary—Roy M. Wilcomb, city manager, Springfield, Vermont.

This association will hold quarterly meetings each year, one in each of the states.

Methods of Sludge Disposal for Small Sewage Plants

Seven Ways of Preventing Sludge Accumulation at Plants

By FRANK BACHMANN
Sanitary Engineer, The Dorr Co., Chicago, Ill.

THIS discussion deals with the disposal of sludge from septic tanks, Imhoff tanks and separate sludge digestion tanks which are in common use throughout the country.

Methods of Disposal.—The following methods of disposal of digested sludge from all types of tanks are in common use:

1. Discharge into stream during flood flows.
2. Lagoons.
3. Filling in low lands.
4. Direct onto land and ploughed in.
5. Dried on prepared sand beds.
6. Dried sludge used as fill.
7. Dried sludge used as fertilizer.

The first five methods refer to wet sludge as discharged from the tanks and the last two to the disposal of air dried sludge.

Discharge into Streams. — Many plants both large and small make use of streams during flood conditions to dispose of their sludge. This procedure is usually not approved by the state board of health but there are instances where no harm is done by this method, especially where the streams are large and the sludge is discharged at the proper time. In most cases. however, evidence of sludge along banks of stream, on vegetation and deposits in the stream itself are noticeable for some time after the discharge of the sludge. As a general practice this method of disposing of sludge is condemned as being unfair to the inhabitants below and in its unreliability because of the uncertainty of the duration of flood conditions. This method is used more in connection with septic tanks which are pumped clean periodically than with any other type of tank, although the sludge from a few Imhoff tank installations is disposed of in this manner.

Much has been written on the disposal of sludge from the larger sewage plants throughout the country where technical supervision is available but little has been said of this problem for the smaller plants. In Ohio, for instance, 80 per cent of the sewage plants serve populations of less than 7,500 people and this percentage is, no doubt, exceeded in some of the western states. The disposal of sludge from the smaller plants is, therefore, of interest to a large number of city officials and operators, and we accordingly are reprinting below an interesting paper on this subject which was presented last November at the Iowa Sewage Treatment Conference.

Along the seaboard it is quite customary to pump the sludge into the ocean during winter months when there is no bathing. Reports indicate that no harm results with this procedure.

Lagooning Sewage.—Lagooning of sludge is not common in the smaller plants. Lagoons, where used, consist of natural or artificial holes in the ground and are usually in sets of two or more for flexibility. Lagoons are from 3 to 10 ft. deep and sludge is run into them until they fill up, after which the sludge is allowed to drain and then is hauled away. Lagoons serve their purpose satisfactorily if they receive a well digested sludge but with a raw or partially digested sludge they usually smell badly. Aside from an odor nuisance lagoons are a source of mosquito and fly breeding. There are very few lagoons being installed today for disposal of sludge because of the objections mentioned.

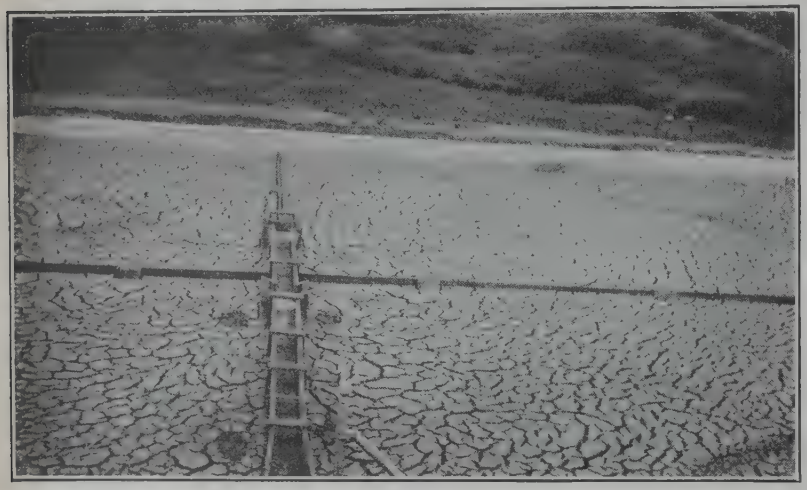
Filling in Low Land.—Where low land is available sludge has been disposed of with satisfactory results by using it to fill in this low land. This is usually only a temporary expedient as other methods must be used when the fill is completed.

Disposal into Land and Plowing In. —Sludge is as a rule disposed of during the summer months and where farm land is available sludge is disposed of by discharging directly on land and after the sludge dries it is ploughed in. This procedure is followed successfully at a number of small plants and has been entirely successful at the large plant at Canton, O. Sludge is usually taken from the tanks during the dry summer months of the year when land will absorb the water readily. This method is in quite common use in the south and on the West Coast where the water in the sludge has a distinct value to crops in addition to the fertilizer value of the sludge. With a well digested sludge, disposal is without nuisance and the fertilizing value of this material will surprise the most skeptical farmer. This method has not been given the credit it deserves and in locations where farm lands are adjacent to the plant it is an economical and practical solution for the sludge disposal problem. Common sense should prevail in distributing the sludge over the land. Excessive amounts in spots are certain to give pooling and thereby retard the drying period. The sludge is usually run into a main ditch from which lateral ditches serve the land.

Drying on Prepared Sand Beds.— The more recent Imhoff and separate

Some Examples of Poorly Drained and Unkept Sludge Beds

sludge digestion plants are provided with specially designed sand beds for dewatering the sludge. If there were sand beds constructed for septic tanks, it it usually hard to find them as they are buried in weeds. Sludge is run onto the sand beds from 6 in. to 15 in. deep and with good weather is in a spadable condition in one to two weeks. Experience has shown that it is more practicable to dose the beds more frequently than to attempt to dry too great a depth. About 9 in. is a good depth of sludge on the beds and greater depth over this may delay its drying. The drying time for sludge depends on weather conditions, depth of sludge applied to beds; and, lastly, but of most importance, is the character of the sludge. A poorly digested sludge may not dry for months, whereas, if well digested it should dry in 6 to 14 days. Sludge as discharged onto drying beds contains 90 to 95 per cent water and will dry to 60 per cent moisture and lower. When in a spadable condition, the sludge should be taken off the beds immediately so that it will not be rained upon and get mouldy. If properly digested, the sludge will not give off offensive odors during the drying process. The dried sludge has a slight odor of humus which is not objectionable. The dried sludge can be piled up near the beds until ready for final disposal.



This Shows a Well Drained Sludge Bed at Hartford, Wis., Also a Good Sludge as Indicated by Its Small Cracks

Dried Sludge Used as a Fill.—The two outstanding methods of disposing of the dried sludge are by using it to fill in waste land and its use as fertilizer. Many plants pile up the sludge near the plant to the detriment of the appearance of the plant grounds. If low ground is not available at the plant provisions should be made to haul the material elsewhere. More attention paid to the appearance of the plant by the operator will result in the town taking an interest in spending money on operation and improvements. Sludge piles around a plant are an eyesore and in this age of progress the value of the sludge as fertilizer is well known and appreciated by the wide-awake farmer who will take all the sludge that is produced without cost to the city.

Dried Sludge as a Fertilizer.—This statement might seem a little optimistic but if an operator cannot induce the farmer to take his sludge, he is considered a poor salesman. We have heard for the past twenty years or more that digested sludge has little fertilizer value. This is true relatively when based on the chemical analysis and compared with commercial fertilizers. Sludge contains valuable ingredients which are not shown by the chemical analysis and which have the effect of loosening the soil and stimulating bacterial growths. Experiments on laboratory scale and in actual practice have shown the great value of this material as fertilizer.

One thing which has made the farmers skeptical is the fact that the material is had for the asking. It is much easier to sell an article of this kind than to give it away. A story comes to mind which illustrates this point, and which is entitled **A Better Method.** "I don't know what to do with this mongrel," moaned Jones, "I've done my best to give him away." "Give him away," protested his up-and-doing wife. "That's no way to get rid of a dog. Ask $20 for him."

Large quantities of dried digested sludge are used for fertilizer in this country, much more than most of us realize. Large cities like Baltimore, Md., Rochester, N. Y., Madison, Wis., Marion, O., and others, have sold the sludge at a nominal price for fertilizer for many years. Hartford, Wis., with about 4,500 people and Kiel, Wis., with 1,600 people use all of their sludge on lawns and shrubbery in the parks in which these plants are located. Many plants have made arrangements with farmers to remove the sludge from the drying beds in payment for the sludge.

Col. E. D. Rich, Director of Bureau of Engineering, Michigan Department of Health, states that the following towns and others in his state are using the sludge as fertilizer: Romeo, pop. 2,500; Grosse Pointe, pop. 3,000; Lapeer, pop. 3,000; Fremont, pop. 2,000; Muskegon Heights, pop. 15,000; and the city of Pontiac with population of 50,000 disposes of its sludge at a price of fifty cents per load. Sludge has been accumulating around this plant for about 3 to 4 years. Offers to give it away failed. The perseverance of the operator and possibly the establishing of a price for the sludge were responsible for interest in this sludge as all of it is sold and none accumulated because of the demand for it.

Many other instances could be cited but the examples given should be convincing evidence to any farmer that this material has value as a fertilizer. From the viewpoint of the operator, his main object is to get it off the sewage plant site even if a revenue is not obtained. A small charge may have its psychological effect in creating a demand for the sludge.

It is hoped that this article will be helpful in pointing out a way to have the sludge removed from the plant sites so as to make it possible to keep the grounds appearing in a respectable condition.

Cincinnati Adopts Uniform Standard Design for Street Casting

All street castings used by the various city departments of Cincinnati hereafter will be purchased under the direction of the city manager. The purpose of this arrangement is to secure a single standard specification for all types of inlets, manhole covers, and gratings, of the best possible design, and of a sufficient strength to carry the heavy loads of modern traffic without breaking, and particularly to do away with the noisy rattling and rocking of manhole covers that has been such a nuisance in Cincinnati and all other cities in the past. These manhole covers will, in future, be machined to an absolute fit so there will no longer be any noisy rattling of these covers.

It is expected, through the co-operation of the Utilities' Companies, to secure in the near future a similar arrangement in regard to their castings used in the streets.

The "Come Back" of Toll Bridges.—On Jan. 1, 1928 there were 233 toll bridges in the United States, 191 of which were privately owned. Since that time construction has been started on 29 new ones, and 163 are proposed. Of the 233 existing the first of the year, 86 were built in the last ten years.

How New York City Use Statistics for Accident Prevention

How Investigation of Accidents Leads Way to Prevention

By PHILIP D. HOYT
Deputy Police Commissioner, New York City

THOSE of us who are responsible for traffic control in New York City know the importance of using facts in deciding upon our traffic program. Traffic counts, speed tests, and other factual data which we obtain, are used almost daily; but no set facts that we obtain are more important than the accident statistics which we use in our plans for traffic control.

The traffic problem is one of many phases. City or regional planning, the study and initiation of engineering projects which will provide additional facilities, is one of them. Regulation or handling of traffic with existing facilities is another. Discussion of the traffic problem too frequently considers one purpose of regulation—the acceleration of traffic, and ignores or minimizes the more important function, the protection of human life. Speeding up traffic is of course an essential object of regulation, but public safety comes first. The primary duty of the police in handling traffic is no different indeed from its duty to protect society against the criminal element. That is why traffic regulation generally lies in the hands of the police.

The complexities of the traffic problem in New York City are increased not merely in proportion to its population, but because of many other factors, some of them peculiar to this city. The geographical barriers which divide and surround the city; the density of population; the height of the buildings; the number of automobiles; the extent of the suburban district—all complicate the situation. Handling traffic safely under such conditions on the city's five thousand miles of streets, is a task calling for the utmost effort.

Accidents Reduced.—Our toll from street accidents is high; yet we feel we are making some progress in our attempt to serve human life by a thorough and systematic study of accidents. Last year, for the first time since the appearance of the automobile, the number of fatalities and injuries to both adults and children resulting from highway accidents in this city, decreased from the preceding year. The fatalities from motor vehicles in this city in 1927 were 17.8 per one hundred thousand of population. The figures of the National Safety Council show that the general rate for the entire country, urban and rural, was 19.6 per hundred thousand, while the urban rate was 22.4.

The most encouraging fact, however, is that since 1923 there has been a steady reduction year after year in fatalities to children of sixteen and under, due to highway accidents in New York City. In 1923 there were 453 children killed; in 1924, 432; in 1925, 422; in 1926, 413, and in 1927, 408. In the first eight months of this year 218 children were killed as compared with 266 during the corresponding period last year, a decrease of 18 per cent. It is not, however, my intention to burden you with figures. Those I have just referred to are sufficient to give you a picture of the accident situation in this city and to show the decided progress in the reduction of accidents. This is due in no small measure, in my opinion, to our use of accident records. It is my purpose in this discussion to tell you something about our system of collecting, classifying and using these records.

Accident Card.—The information relating to each accident involving death or injury comes in the first instance from a report made out by the patrolman on post. A printed card used for this report calls for certain specific information. The principal causes of accidents are specified on this card, so that the patrolman who has occasion to make out the report knows exactly what information we require. On the back of the card is a blank space calling for the details, for purposes of further classification. Our total force of 17,500 policemen is at our service in investigating accidents and making out these reports. One copy of the report or printed card goes to the local police station, in the district where the accident occurred. Another goes to the Information Bureau at Police Headquarters for various uses which will be referred to, and a third goes to the Accident Record Bureau of the Traffic Division, also at Police Headquarters. The Captain of each of the local precincts keeps his own file of these cards and prepares from them a precinct spot map of accidents in the district of which he is in charge. Each Captain is thus able to keep in close touch with the situation in his locality. The cards returned to the Information Bureau are used for a variety of purposes, such, for example, as checking up persons who have been reported missing, and who the cards may show have been removed to a hospital following a highway accident. The cards returned to the Traffic Division are first classified by names alphabetically. Reports are received daily from the Medical Examiner, and these are carefully checked; so that when an accident victim reported as injured later dies, the report may be corrected.

Causes Listed.—Every accident is next listed as to the cause. Seventy different causes are included in this classification. The cause records are the basis of a monthly report. The next classification is according to location. This is made in three ways. First, by a file of streets and avenues; second, by police precincts, and third on spot maps which show the location of all accidents involving death or injury for each of the five boroughs of the city. Further classifications are made as to the hours of accidents and the ages of the victims, divided into several groups. In the case of children sixteen years old or under, several special classifications are made. These are according to ages, hours, school districts and schools.

All these records being merely collected, classified and filed away would be of little value. To avail ourselves, therefore, of this store of information is our next task. It is one to which we have devoted considerable thought in an effort to develop a system that would be of material aid in reducing traffic hazard. The monthly summaries are carefully studied. Our first interest is in the total for the month and the comparative figures for the preceding month and preceding years. Are accidents increasing or decreasing? Are children or adults the victims? What are the principal causes? Are they on main avenues or side streets? What hour do they occur? The answers to these and similar questions are found in the summaries and they give us a general idea of the accident situation in the city.

Locations Studied.—Closer study is made of the localities of accidents. This street has a high record. Is it because of the lack of traffic control, or inadequate regulations? The locality classifications are of particular interest in our planning of traffic control light systems; in fact, they are the basis of our request for appropriations for that purpose. Traffic lights may be provided where policemen may not. By the end of this year some 3,500 intersections in this city will be controlled by traffic lights. It would take about seven thousand policemen to cover these crossings

during the hours when the lights will be in operation, involving an annual cost of more than seventeen million dollars. That does not mean we save that amount by supplementing traffic officers with traffic control lights, but it does mean that traffic lights will provide control at nearly three thousand intersections where otherwise control would be impossible, not only from the standpoint of cost, but because of the difficulty of obtaining and training that number of additional men of the right calibre.

So in planning our traffic light programs, the reports showing just how many persons were killed and injured on each thoroughfare of the city are of the utmost importance. The assignment of the three thousand men detailed to traffic duty in this city and the sixteen hundred others who do special duty in the vicinity of schools, is another task calling for frequent reference to the locality record.

Special Regulations.—In addition to the general regulations which the Police Department makes for the control of traffic here, several hundred special regulations affecting particular localities are made each year. In our consideration of the necessity for such regulations, many of which are requested by residents or civic organizations in the various neighborhoods, the locality accident records are of great use. These records also aid in the direction of the activities of the police in enforcement. They often tell us where more attention should be given to speeders, or that drivers are not observing strictly the regulations covering turns, right of way, or other rules.

Investigation Squad.—In order to go more deeply into accidents involving deaths in this city, the Traffic Division has recently inaugurated a system providing for a more detailed investigation of such accidents. Every death now occurring in the city as the result of a highway accident is investigated by a special squad, operating from Police Headquarters. This squad is composed of experienced traffic men who work in uniform. The work is so distributed that the investigator can give a full day to each fatal accident. Although the information received from the patrolman on post is quite complete, there are frequently conditions at the points where accidents occur which the ordinary policeman does not feel the responsibility to investigate and make the basis of recommendations to his superior. The members of this special squad, being few in number, know exactly what information is required, and their business is to make recommendations to improve traffic conditions at that point. The investigator visits the scene of the accident at the same hour of the day when it occurred. This enables him to take into account all conditions at that particular time, such, for example, as the volume of traffic, street lighting, or many other factors. The investigators are all draftsmen, and their report includes a diagram of the locality, showing all the physical conditions and the position of the vehicles or pedestrians figuring in the accident. Specific information covering several points is required in the report—whether there was a traffic post or a traffic light at the point involved; the street lighting condition; any special traffic regulation, such as one-way street; and the condition of the pavement. These reports are taken up in conference with the patrolman who wrote them, and there is a thorough discussion of conditions at each point, for each fatality, so that we may get an answer in each case to the question whether anything possible can be done to improve conditions.

Jurisdiction.—Many of these recommendations naturally come within the jurisdiction of the Police Department. Attention may be called to a crossing where traffic lights or traffic policemen should be provided, warning lights indicating dead end street, for example, or various other traffic regulations of a cautionary nature may be necessary; regulations such as one-way streets may be advisable. The investigator's visit may result in the discovery that particular attention to enforcement should be given at this point. White lines to designate pedestrians' crossings may be needed. Many recommendations relate to other departments. Street lighting conditions may be in need of repair or improvement. Repairs to highways or bridges may be necessary. The highway facilities may be inadequate, requiring engineering measures for relief. In some cases the recommendations relate to individuals or private agencies, involving, for example, the routing of vehicles to less congested sections. The investigations frequently disclose facts of interest to the school authorities and their cooperation is sought.

This system of a detailed investigation of fatalities, although comparatively new, and by no means fully developed, has been found to be of the greatest assistance to us in improving traffic conditions.

So you see there is hardly a step in our traffic program, whether it relates to the assignment of personal investigators, the placing of traffic equipment, or the use of our broad regulatory powers, that is not based upon our accident experience.

In addition to the uses which the Police Department makes of our records, these records are also constantly being supplied to private agencies for use in accident prevention. They are supplied in detail to safety organizations. Organizations interested in the extension of the playgrounds throughout the city obtain them regularly to support their requests for additional recreational facilities.

Safety Education.—One of the most important uses of these records is in connection with the safety education program which the Board of Education is carrying on in this city under the personal supervision of Dr. William J. O'Shea, Superintendent of Education, and also in the parochial schools in the five boroughs of Greater New York. Every month an analysis of accidents involving children of sixteen or under is sent to the school authorities. This analysis stresses the causes of accidents and shows how these accidents vary from month to month. By means of these analyses the school authorities are able to determine what careless practices lead to accidents, and to impress upon the children the need for personal carefulness in these respects. Each of the twenty-seven school district superintendents receives a report for his district. A separate report is prepared showing the number of accidents involving children attending each of the 994 schools in the city; so that each school principal may learn every month whether the accident toll for his school is decreasing or mounting. The value of educational methods in accident prevention cannot be too highly estimated. Our own experience shows that can be done, although thus far we have made only a beginning.

One of the most important uses that can be made of accident statistics, in my opinion, is in safety education. This can best be accomplished through the schools. Safety education in the schools has been greatly developed during the last few years, but its possibilities as a regular part of our school program are only beginning to be realized. Teaching the children how to take care of themselves under present-day traffic conditions is a duty no less important than teaching them reading, writing or arithmetic. Safety instructions, furthermore, can be combined with those and other subjects of the regular curriculum without taking any additional time. Such instructions, in fact, can be so planned that it will stimulate interest in the subjects into which it is incorporated. Education is not my forte, but I feel so strongly on this subject that I cannot refrain from making this reference to it. Personal safety, in my opinion, should be an acknowledged subject of instruction in the schools throughout the country. The importance of such a program is recognized. It remains only for some countrywide educational organization, perhaps some great educational foundation, to get behind this movement, in which great strides have already been made, and develop a systematic, comprehensive plan of safety education, which will be generally accepted as an essential part of the training of our youth. There is no accomplishment that I can think of that would be more worth while.

Acknowledgment.—From a paper read before the recent National Safety Congress, and reprinted with permission of the National Safety Council from the Transactions of the Congress.

Some Problems of Water Distribution in New York City

Providing and Maintaining Servicea ble Pressure in Distribution System

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IN New York City the introduction of the Catskill supply, delivered by gravity at a much higher head than the original Croton and other supplies, made possible extensive improvements of pressure and changes and extensions of service zones and involved many radical changes in distribution. These were local conditions for New York City that have added materially to those problems, common to all cities, of providing adequate distribution to meet the present and prospective demands of sectional development, population increase, etc.

In New York City the Croton supply is delivered by gravity at a head of 133 ft. above sea level at Jerome Park reservoir near the north end of the city, and is carried southward through original aqueduct lines, terminating in Central Park reservoir at 118 ft. above sea level. The Catskill supply is delivered by gravity at 293 ft. above sea level at the north city line and from there is conveyed by 18 miles of deep rock tunnel through the west side of Bronx borough and throughout the elongated island of Manhattan to Brooklyn. This Catskill supply is available for these two boroughs from 18 riser shafts along the line of the tunnel, instead of having to be conveyed southward by trunk lines as with the old Croton system.

Four Service Zones.—To correspond with the topography of the boroughs of Manhattan and the Bronx, the system includes four service zones, supplied under heads suitable for service to the ground elevation included in each. These are: Low service supplied by Croton water under gravity head, intermediate service supplied by pumped Croton, together with Catskill under reduced and regulated head, high service supplied by Catskill gravity or full head of the Catskill tunnel and tower service of Manhattan supplied with Catskill and Croton pumped to about 50 ft. above the available Catskill head for adequately serving the area of highest elevation.

In general the aim has been to utilize the original Croton gravity as fully as possible, reserving Catskill for the higher areas and to save pumping. Unnecessary extension of Catskill service into areas where Croton gravity could be feasibly used by proper changes or reinforcement in the distribution system has been avoided.

This feature was a factor in a recent problem of improving supply to roughly 10 square miles of East Bronx low service area, where a tremendous post-war expansion and building development had rendered the original small supply and distribution mains seriously inadequate in maintaining serviceable pressures under the low Croton gravity head. The need was apparent for a comprehensive hydraulic, or gradient survey, to determine the necessary size and location of needed trunk mains or other changes required, and such a survey was made in the latter part of 1924.

How One Problem Was Handled.—With the center of distribution about 4½ miles from the source and limited by the head of 133 ft. at that source it was considered economically feasible to maintain the area below the 40 ft. contour on the Croton low or gravity service. This would allow a 24-ft. pressure loss in maintaining a minimum of 30 lb. at the 40 ft. or highest elevation.

In determining the location and size of main needed, other less tangible though important factors have to be estimated and used. These gradients were obtained in December, 1924. It was estimated that maximum summer-time consumption in that area, including large summer tent and bungalow colonies, would be 25 per cent greater than in December, giving pressure losses 50 per cent greater than those indicated. Also it was assumed that at the rate of development then under way the consumption of the area might double in five to ten years. Thus the maximum near future consumption might reach 200 per cent of that existing at the time and season of the survey.

The positive data on existing conditions, as presented on the map, clearly indicated by gradient slope, the location and length of needed trunk mains. The size of main was determined by assuming an increase of flow, corresponding with the estimated increase in consumption and selecting a size sufficient to carry such a flow with a loss of head reduced to an amount corresponding with good practice and safely within the limited allowable margin between the supply source and the distribution thus not only to improve the pressure but to maintain it against reasonably distant future demands.

The recommendation for new mains, based on this survey, included 8,000 ft. of 36-in., 11,000 ft. of 30-in. and 19,000 ft. of 20-in. It was estimated that the larger sizes recommended as supplies would include pressures by about 4 to 5 lb. The 20 in. was mainly intended to strengthen the grid for fire supply and to so inter-connect the two larger supply mains that either could serve alone in emergency.

Extending the Bronx Intermediate Service.—Since introduction of Catskill supply the Bronx intermediate service has been greatly extended. Two large north and south trunk mains of the original Croton system, one on the east and one on the west side, have been utilized. The present main source of supply for this service, as previously mentioned, is from Catskill shafts along the pressure tunnel lying west of the service and paralleling those original main arteries. The lack of trunk main capacity in an easterly direction from the tunnel to the original main and centers of distribution has been overcome by hand regulation at the shafts, increasing the day-time pressures and output at these points to that necessary to maintain serviceable pressures at the center of distribution and reducing at the source to avoid excessive night-time pressure increase on the distribution system. The problem here presented did not involve the design of a system of reinforcement to provide serviceable pressures with a very limited head at the source, but rather the determination of size and location of main necessary to so reduce the excessively varying pressure losses as to permit maintenance of fairly uniform pressures on the system with a comparatively constant head at the tunnel. Such a condition is also desirable to permit more automatic regulation to replace hand regulation and to obviate unavoidably serious pressure fluctuations at extremities of the system. In the solution of this problem a gradient survey was made using the same method as previously described. In this case, however, on account of the wide fluctuation due to high pressure losses, extra care had to be exercised to have the gradients obtained under practically simultaneous and normal conditions in order to be comparable in any combination on the final skeleton map. This required some repetition of work and averaging of results, but the variations on repeti-

tions of tests were generally negligible in comparison with the pressure losses determined.

Omitting details, the final map of results showed very flat gradients along those two original north and south trunk mains considered as "headers," but a serious day-time slope or pressure loss between the pressure tunnel and the westerly 48-in. header of 53 ft. determined along the 3,500 ft. of 36-in., constituting one of the main supplies. Also an additional loss of 25 ft. in the 9,000-ft. continuation of this main to the easterly header. The map presented other quite serious additional losses along secondary feeders so that, for example, at one point well within the service area the day-time head was 93 ft. or 40 lb. below that maintained on the supply main at the shaft. As before, the desirable location and necessary length of new mains was quite apparent on the map. The determination of size was made by selecting one whose capacity relative to existing mains, and when working with them, would be such as to bring these excessive pressure losses down to those corresponding with good practice and well-controlled pressures. The mains recommended included 4,000 ft. of 49-in. to eliminate the excessive pressure loss between the tunnel and the westerly 48-in. header and 11,000 ft. of 36-in. from this header to the easterly one to more nearly equalize them.

Such surveys establish the gradients available throughout the existing system, which together with the determined elevation of hydrants, or more roughly the street atlas elevations is used daily on investigations of pressure troubles and by the information desk in answering inquiries as to pressure at specific locations.

Gradient Survey in Manhattan.—In the borough of Manhattan a gradient survey of somewhat different character was made primarily for use in promptly solving these every-day and important problems. Briefly, it consists of a series of east and west gradient profiles of "hydraulic cross-sections" of Manhattain Island taken approximately ten blocks apart from the Battery to Spuyten Duyvil. It includes about 300 hydrants on all of which pressures were taken during the business hours of one day. The pressures were taken with accurate gauges that had been previously tested and calibrated and the corrections applied to the gauge readings in the computation. The nozzle elevations were determined by levels. These hydrant locations, elevations and gradients are listed by streets in geographical order and used daily by the parties on pressure investigations. For office use a street wall map is used, in which the four service zones are shown in color and the gradient of the service at different general locations indicated in large figures that can be read from the distance of the complaint and information desks.

These gradients were taken in September, 1923, under generally normal distribution and weather conditions and have been found very useful as standard reference gradients for solution of the varied problems involving depreciation of service due to increase of consumption and need of reinforcement, or the improvement secured by new installations or changes in distribution. They are useful in locating breaks in mains, open blow-offs, closed valves or restricted circulation and for intelligently advising a complainant as to whether his complaint is justified or due to local trouble under his own control, advising him what pressure to expect on the street main, and whether new or larger plumbing will improve conditions and supply to his top floor. They point promptly to open service boundaries, unwise changes in shaft distribution or regulation, etc. This gradient net work indicates very conspicuously the areas in need of better supply mains and it has been used together with special gradient tests as a basis in solving the problem of determining the size and routes of large trunk mains. Thus about 2,500 ft. of 30-in. steel and 4,500 ft. of 20-in. and 16-in. cast iron main have been laid east and west from one Catskill shaft to flatten the gradient and to relieve the over-load previously carried on the shaft next adjacent along the tunnel; 4,350 ft. of 36-in. steel main was laid to reduce a 16-ft. gradient slope across Central Park and improve pressures on high ground to the east. A contract is now under way for about 4,200 ft. of 48-in. and 3,800 ft. of 36-in. from 48-in. low service aqueduct mains eastward to improve upper east side low service pressure by reducing the present gradient slope of 32 ft. (or 14 lb. loss) in 5,000 ft. Contract is to be prepared for about 4,500 ft. of 30-in. main to reduce a present pressure loss between the Catskill tunnel source and the extremities of the system of 25 to 30 ft., and more fully utilize a Catskill shaft where output is now restricted.

Fire Supply Problems.—Fire supply presents an ever-present problem in all distribution systems. If the area in question is large and a possible fire draft a small percentage of the total consumption, the solution of the problem probably does not involve consideration of trunk mains, but rather tests to locate points where possible fire draft would exceed the limited capacity of the local grid-iron mains. If the consumption of area be small in comparison with a possible fire draft the solution may call for supply mains larger than necessary for the normal domestic and business consumption, in other words, the provision of suitable fire supply in such areas carried with it ample provision for daily consumption. In New York and other large cities, the areas involving the greatest hazards are protected by an independent fire supply system on which the pressure is raised at times of fire to suit the demand. Outside such protected areas of New York City, the solution of the problem of fire supply is based on tests made substantially as in other cities. A group of hydrants is selected for simultaneous discharge. Another hydrant on the side of the group opposite the apparent supply, or possibly within the group, is selected for observation of static and residual pressures. On signal from the man in charge, the observer at each discharge hydrant opens his hydrant fully and measures the discharge head by means of a pitot tube attached to a low reading pressure gauge, the gallons per minute discharged is obtained from curves of discharge at the various pressures and nozzle sizes. The observer at the pressure hydrant notes the static or normal pressure and the residual pressure with all hydrants open. The limit of capacity of the system at that location is estimated as the total discharge obtained from the group multiplied by the square root of the ratio of the static pressure to the drop in pressure observed with all hydrants open. If this limit of capacity falls below the requirements, of say third or fourth alarm, fires for that area, depending upon the hazard at that location, the final solution of the problem involves provision of mains whose size and location is usually obvious.

Occasionally the problem of safeguarding domestic and fire supply for an isolated high service area may be solved by insertion of check valves on the boundary between that and an adjacent low service of sufficient head to reach the high ground and under the head as reduced by the emergency demand. Such valves, if not in occasional action, should be watched and frequently tested.

Controlling Pressure.—In the problem of controlling the pressures in a system supplied by reduction of head at the source, automatic pressure regulation valves are frequently the logical solution. Such valves are used on the New York system, but usually not as extensively as originally intended. In general the non-use is not a discredit to the valve but has been due to the unusual condition imposed on its operation. The pilot valves of the automatic regular are actuated by variations of its down-stream pressure. In an overloaded supply main with a high friction loss between the source and the center of distribution the variations of demand in the system are not effectively transmitted as variations in pressures at the pilot valves, due to the law that the pressure loss varies as the square of the flow or demand and a serious increase in demand and consequently a much more serious pressure drop on the system is required to actuate the regulator at the source. Also a regulator midway on such a line cannot operate satisfactorily due to the added disadvantage of a highly varying

head on the up-stream side, the regulator tending to maintain a constant difference of pressure, transmits these variations to the down-stream side. Regulators working in parallel with nearby interconnection of their discharges have given unsatisfactory results due to the tendency for one of them to close as the other opens and vice versa. Where pressures have to be raised excessively at the source to maintain day-time pressures on the system the difficulty of utilizing regulating valves is obvious.

Underground Leakage.—The problem of control of underground leakage is a subject by itself and too broad to be included in this miscellaneous paper. It is, however, an important one, especially where subsurface conditions permit development of large and extensive leakage without surface indications. In New York City these conditions obtain in a very marked degree in the two boroughs of Manhattan and the Bronx. During years of plentiful supply and with a very small available force for the purpose we have been unable to do more than locate and repair leaks responsible for complaints of flows into basements, electrical conduits, steam lines, subways and other subsurface structures.

In the regular course, such complaints are received at the complaint desk of the main office and the order for investigation 'phoned to the repair shop of the district concerned. This order is followed by a copy of a written order, the original remaining at the office. Space is provided on the order blank for the foreman's report. When the leak is not found after a reasonable effort it is referred to the special waste detection force and is given study under engineering supervision. Practically every case thus referred is different and requires original and serious engineering study on the ground (and of conditions below ground) to solve the problem and locate the source, frequently a few blocks away, through a maze of subsurface conduits, gas and water mains, vaporizing steam lines, transit subways, etc.

It is anticipated that at or about 1935, New York City's consumption will have reached the capacity of its source of supply, and as this will probably precede availability of additional supply conservation measures are now being considered and adopted. Systematic surveys to locate and repair underground waste, much of which exists without causing complaint are being considered. One or two field parties are now being used on such surveys with the main object of determining how much underground leakage of this character can be stopped, what the cost will be per million gallons saved, what force and organization will be necessary to cover the fruitful fields in the reasonably few years available.

Aside from the saving of water such surveys by small districts are a decided help in maintenance by incidentally locating and correcting various defects, closed valves, open service boundaries, restricted circulation, etc. On the second of these experimental districts now under investigation an unexpected pressure drop occurring on the closing of the boundaries to isolate the district led to the location of a 6-in. wide open blow-off on a 20-in. main discharging 6 m.g.d., measured, into the sewer. This blow-off had not been indicated on distribution maps since about 1908, but from other evidence it is assumed that the blow-off had not been opened that length of time. We do not expect such "finds" in all of the trial districts to be investigated, but this case found in the second district investigated serves as a suggestion of one possible source of tremendous unobserved waste in a system that include hundreds of such blow-offs, and but for the district waste survey this one would still be running.

Acknowledgment.—The above is an abstract of a paper presented at the last annual convention of the New England Water Works Association.

Centralizing Control of City Machinery

The city of Reading, Pa., has recently centralized the custody and maintenance of its equipment such as motor vehicles, pumps, fire engines, etc., in the hands of one official. The office of supervisor of public machinery has been established, his duties being outlined as follows in the ordinance: He "shall have the care, management, direction, control and administration of the maintenance and repair of all motor vehicles, fire apparatus, pumps, and other machinery of every kind and description belonging to or used by any of the departments, bureaus, boards and other agencies of the city. All such departments, bureaus, boards and agencies shall obtain all repairs and replacement parts for machinery through the supervisor of public machinery, and not by direct contract with private parties, nor by having said repairing done under their own supervision. It shall be unlawful for the city controller to countersign, or the city treasurer to pay, any warrants or checks for repairs to, or replacement parts for machinery, except upon certificate of the supervisor of public machinery, that such parts or repairs have been obtained by his authority and under his supervision."

The supervisor is given authority to organize and manage a municipal machine shop in which all repairs to public machinery are to be made. All necessary equipment and repairs are to be procured through the office of the city purchasing agent.

Short Course in Public Administration

The short course in public administration held last summer at the University of Southern California was a decided success, and it is probable that it will be repeated in 1929. The individual attendance in various sections was 749 and the total section attendance was 5,430. The public occupations and positions represented by those in attendance comprised Assessors and Tax Collectors, Board of Education and Superintendents of Schools, Budgets and Efficiency, Bureau of, Building Departments and Building Inspectors, Chambers of Commerce, Clubs, and Organizations, Citizens, Clergymen, Clerks, City and County, Commercial Firms, Controllers, Treasurers, Auditors, Accountants, Councilmen, Engineers in Public Work, Fire Departments, Health Departments, Legal Departments, Managers, City, Mayors, Miscellaneous, Planning Organizations, City and County, Playground and Recreational Departments, Police Departments, Probation Department, Purchasing Agents, Social Welfare Workers, Street Traffic Organizations, University Students, Water, Power and Light Departments.

Average Life of Street Department Horses at Toronto, Ont.—The average life of a horse in the service of the Department of Street Cleaning of the City of Toronto, Ont., is 6½ years, according to the 1927 report of George W. Dies, Street Commissioner. The care of the department's 334 horses is under the direction of a veterinary surgeon, whose services are engaged on a per capita basis of $4.00 per horse per annum. His duties are to render the necessary veterinary services to sick horses, advise as to the proper feeding of the animals, and the necessary sanitary precautions against disease. He also examines and certifies as to the soundness of all new purchases, and condemns animals unfit for further service. During 1927 48 horses were purchased at an average price of $230 each. A card record is maintained of each horse as to date and from whom purchased, price, color, markings, age, height and weight. The time lost by horse, due to illness or other causes, is also recorded, as well as the date of disposition, cause, and sale price.

Washington, D. C., Has Spent Over $25,000,000 on Sewerage.—The total length of the sewer system of Washington, D. C., on June 30, 1927, was 868.97 miles of which 166.21 miles were main sewers and 702.70 miles were pipe sewers. The total cost of this system was $19,181,762. The length of the sewage disposal system was 39.52 miles and the cost was $6,237,292.

The City and Abandoned Street Car Tracks

How Some Cities Are Taking Care of the 9 Ft. Strip on Streets

SINCE the bus has superseded the street car in many localities, municipalities are faced with the problem of taking care of the 9 ft. strip which always was considered the direct possession of the utility using it. Cities are faced with a problem which was not anticipated even as late as the past five years. In many cases this area presents a very serious problem as it burdens the taxpayer to an extent which is not provided for in any way. How this problem is being handled in some cities was outlined by L. P. Booz, City Engineer of South Amboy, N. J., in a paper presented at the recent 9th Annual Conference of the International Association of Street Sanitation Officials, from which we have taken the matter that follows:

In some states the operating companies had to maintain the area occupied by their company and had to pave same whenever the street through which they operated was paved. They also had to keep this area cleaned and had to remove the snow therefrom in order to keep their franchise.

With the discontinuance of service and the abandonment of the tracks, the street area which is to be paved and maintained becomes 30 per cent wider and a 30 per cent greater burden to the taxpayer. An additional 9-ft. width had to be maintained, paved and kept clean, at an additional cost to the municipality.

In the State of New Jersey the car lines are automatically relieved of the burden of paving the before mentioned area. Utility companies which have been discontinued and failed because of a lack of travel on their lines, have abandoned the tracks and road bed as they existed. The final disposition of the tracks and road bed material in some localities where the service has been discontinued is still problematical. There is even talk of leaving the road bed as it exists and later continuing the service with its privileges should the necessity return.

The problem as it presents itself consists of restoring the street or roadway so that the public may acquire the full use of same as economically as possible.

The first condition encountered is where the tracks and road bed are abandoned on streets which are now paved to the full width between curbs, including that area paved by the street car company. The removal of tracks together with the ties, guard rails, and road ballast, would be a very expensive proposition, and in many cases the cost would be prohibitive. However, there are places where it is absolutely necessary to do all this work. Where the road bed has not been properly maintained, the ties will be found to be corroded and decomposed and in such condition that the road would continue to cave in because of the insecure foundation.

In some cases it is possible to remove tracks only and replace same with concrete or other foundation, and to surface the area formerly occupied by the track to a level with the surrounding roadway.

A still more economic procedure is to cover the rails with a thin layer of bituminous material which is sloped off on either side, so as not to make too great an obstruction, and allow for safer crossing than the track affords. In wet weather the tracks are often the cause of skidding of automobiles, and many accidents result therefrom. In some cases bituminous filler is used to bring the area occupied by the flange of car wheel to a level with the top of rail. This method can only be used where the grooved rail is laid.

The second condition met in the abandoning of street car tracks is the street in which the area between the tracks has not been paved. In a great many cases the operating companies have merely made a gesture toward maintaining their part of roadway, and with the abandonment of their lines there is a remaining 9 ft. which must be paved by the city, borough or municipal authority having jurisdiction therein. The method of paying for pavement improvements in most municipalities is for the city to pay a share and the abutting property owners on either side to pay the remaining share. This work is financed, bonds being issued for a definite term, and the city's finances regulated to meet the terms of the bond issue. This expense of a 9-ft. width of pavement is added to the property owner's or the city's share of the taxes, immediately causing a direct increase in taxes without any revenue being derived therefrom.

There are many townships in the State of New Jersey and in other states left either with a dangerous area 9 ft. in width as an additional expense, or as a menace to the traveling public. Unless the state and counties take a large share of this burden from the municipalities the conditions seem very unfair.

There are various opinions expressed as to the length of haul which is necessary in order for the street car to compete with the rapidly increasing busses. There are some traffic men who claim that there is a possibility of the street car coming back to take care of certain traffic conditions. The only way to solve this problem to the benefit of the taxpayers and the public at large would be to have the state make a thorough and comprehensive traffic study and make proper determinations as well as assist with the cost of resulting paving.

There is one great benefit to be derived by municipalities in which street car service is abandoned. The constant congestion and interruption of traffic caused by the use of street cars will be altogether eliminated and the public will have the use of the full width of the street. In a great many cities there is only sufficient width between the operating street car and the parked car for one line of traffic. Where the careless motorist does not properly park his car traffic is entirely stopped in that block until the street car passes the next street intersection. In this case the benefit is great and becomes the only cure of a traffic evil which was not anticipated, most of the street car companies having obtained their franchise when the only other street traffic consisted of horse-drawn vehicles. There are some cities in the State of New Jersey in which the street car traffic completely paralyzes other vehicular traffic in the main arteries of travel.

In conclusion I would say that there are many conditions of a local nature with which I am not familiar and which I have not discussed. But I believe for several years hence this problem will be a large and important one until the street cars are abandoned or until they are linked with the busses in an efficient and economical system of transportation.

Swimming Pool Classification in Colorado

The Colorado State Board of Health has divided public bathing places into three general classes according to minimum specifications for sanitation features. Class A bathing places are those in which there is no danger of infection, and their specifications require, among other things, scum gutters, the recirculation, filtration and sterilization of the water, and the maintenance of from 0.2 p.p.m. to 0.5 p.p.m. of residual chlorine in the water at all times that the pool is in use. Class B bathing places are those in which the danger of infection is slight, their specifications including the addition of clean water or the periodic sterilization of the water in the pool as suggested in a previous paragraph. Class C bathing places are those which are unsafe. Due to extremely limited funds and personnel, the classification of the pools in the state has progressed very slowly, but it is hoped that this work can be materially expedited during the coming biennium, so that the people may know the relative sanitary safety of bathing places they patronize and that the unsafe bathing places may be closed.

Routine Records of Collection Service for Refuse Material

Good Operating Records of Collection Service Important

By SAMUEL A. GREELEY
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THE collection of refuse materials is generally recognized as an important part of the refuse disposal problem, and the maintenance of good operating records is obviously essential to the best and most economical service. Nevertheless, there is such a lack of uniformity in records of collection work and service that an examination of the subject is pertinent.

There are two aspects of the collection work which emphasize the need and importance of good operating records. In the first place, the collection of refuse commonly costs more than its disposal. Oftentimes the cost of collection is several times the cost of disposal. If records are kept establishing standards of work and cost, the tendency will be to see and seek chances to reduce the cost.

In the second place, the collection of refuse touches the individual householder more intimately than almost any other branch of municipal service. A high and uniform standard of service to householders should be maintained. Good records of the routine service rendered help materially to improve and remove areas or points falling below the established quality of the service.

Phases of Refuse Disposal Problem.—A pictures of the refuse disposal problem as a whole should be kept in mind, so that the function of the collection service can be properly considered. There are four parts or phases of the refuse disposal problem as follows:

(a) House Treatment.
(b) Collection.
(c) Transportation or Haul.
(d) Final Disposal.

The collection and the transportation or haul have to do with the work of collection units and are closely related. Where the haul from the last point of collection to the place of final disposal is short, the load haul is not so important as in larger communities where secondary or supplementary methods of transportation are required. Thus the collection must cooperate with the house treatment and must deliver the refuse to the disposal place in the most economical fashion.

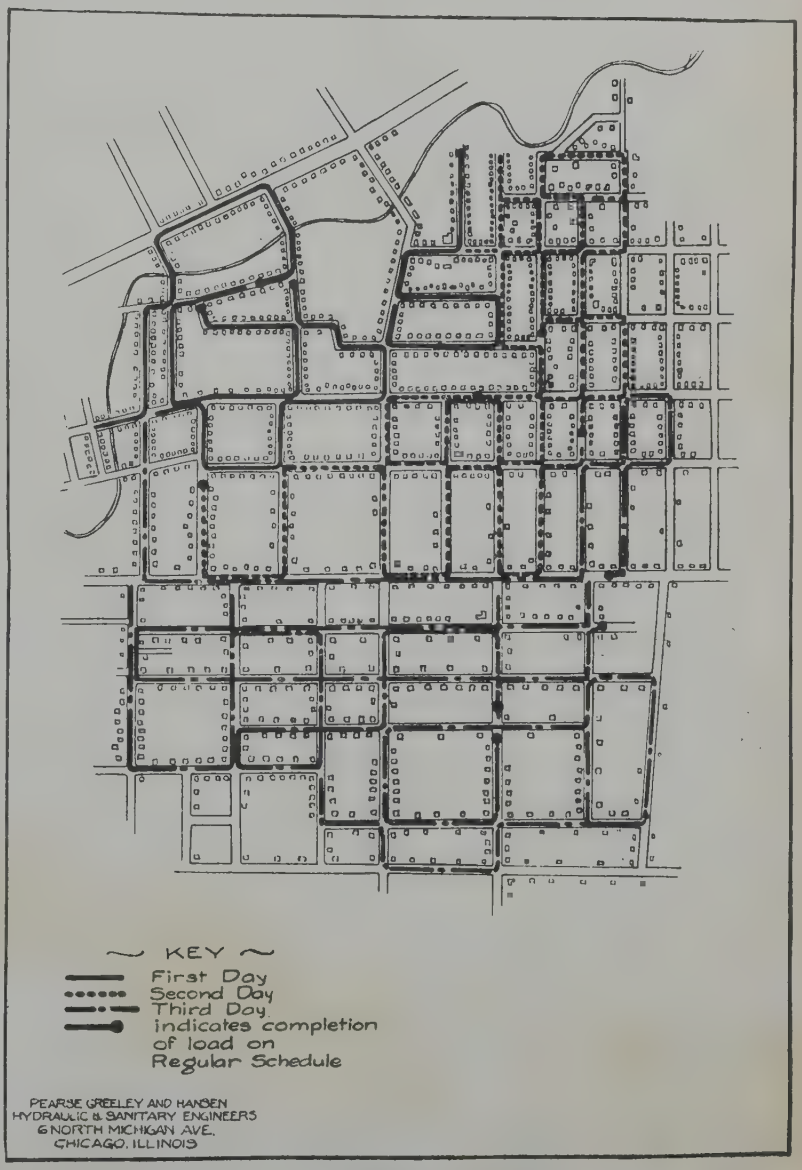
Functions of Collection Service.—The functions of the collection service are:

(a) To visit on a regular schedule every place where refuse is produced and where it has been decided to collect it.

(b) To pick up and haul away the refuse for disposal.

Thus one record or yardstick of the work is the number of houses to which service is rendered; and another is the measure of work done in volume miles or weight miles. Both yardsticks or measures indicate elements or service and cost and can be used to rate the functions of the collection service.

Collection Units.—The term "collection unit" is used to mean the vehicle and its attendants (driver, collector or helper) which actually make the collections. A collection unit may be a small horse-drawn wagon with one man, a horse-drawn trailer with two or three men, a large truck with a chauffeur and



Map Showing Route Record for Collection Unit for Collection of Garbage and Refuse

several collectors or helpers, or any similar vehicle. Different collection units are suited to different kinds of collection work and should, of course, be related thereto. Thus different sizes and types of vehicles are often used for collecting garbage, rubbish or ashes. The proper choice of the collection vehicle has a major bearing on the cost and efficiency of the service and operating records should be such as to guide the superintendent in the selection of suitable vehicles and in the most advantageous arrangement of the collection units.

Operations of Collection Unit.—The most important operations or work items in the routine of a collection unit include the following:

(a) Driving from barn or garage to first place of collection at the beginning of the route.

(b) Entering premises, picking up the accumulated refuse and placing it in the collection vehicle.

(c) Taking the loaded vehicle to the place of disposal.

(d) Unloading (and washing) the collection vehicle.

(e) Returning to a collection route for another load, or to the barn or garage for the night.

There are many minor operations along the way, such as hunting for hidden garbage cans, picking up spilled garbage, breaking out frozen garbage in winter, covering and uncovering the vehicles, reporting or handling complaints and the like. Such items affect the rate of speed of collection and are reflected in the number of houses to which service is given. Some of these operations are worthy of record such as reports on cans and house treatment problems and the handling of complaints.

TRUCK PROGRESS SHEET

Date ..... to .....

	Trip Number	LAST PICK UP MADE FROM MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
UNIT NO. 1 DISTRICT NO 3 DRIVER - R Jones COLLECTOR J Smith	1	17 E Madison St	1620 West St				
	2	321 Flora Ave					
	3	8 Main St					
	4	360 Washington St					
	5						
PICK UPS PER DAY		340					
UNIT NO. ... DISTRICT NO. DRIVER ... COLLECTOR ...	1						
	2						
	3						
	4						
	5						
PICK UPS PER DAY							
UNIT NO. ... DISTRICT NO. ... DRIVER ... COLLECTOR ...	1						
	2						
	3						
	4						
	5						
PICK UPS PER DAY							
UNIT NO. ... DISTRICT NO. ... DRIVER ... COLLECTOR ...	1						
	2						
	3						
	4						
	5						
PICK UPS PER DAY							
UNIT NO. ... DISTRICT NO. ... DRIVER ... COLLECTOR ...	1						
	2						
	3						
	4						
	5						
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UNIT NO. ... DISTRICT NO. ... DRIVER ... COLLECTOR ...	1						
	2						
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PICK UPS PER DAY							
UNIT NO. ... DISTRICT NO. ... DRIVER ... COLLECTOR ...	1						
	2						
	3						
	4						
	5						
PICK UPS PER DAY							

Sheet Used for Recording Truck Progress

The Service Factor.—By service factor is meant the ratio between the total number of houses or points of collection in a district or along a route, to the number from which collections are actually made. In nearly all collection districts there are some houses not requiring collection, including those temporarily unoccupied and those where the refuse is burned or disposed of on the premises. The writer has traveled along collection routes where the service factor is as high as 95 and along others where it was found to be as low as 65 and occasionally less. The service factor is difficult to record on a daily or routine basis but it should be known, at least approximately, but the superintendent who wishes to give intelligent scrutiny to the collection records. The service factor as well as the character of the collection district as to density of population, extent of pavements and the like affects the rating of the collection work in so far as in different districts different rates of work apply. These items should be considered when using collection records.

Elements to Record.—The major elements or routine operating records of collection service include the following:

(a) Bulk Handled. This is a record of the weight and volume of refuse handled by a collection unit. It is sometimes recorded in tons or cubic yards, and sometimes in loads.

(b) Distance Traveled. This is an important index of work and cost. It is frequently recorded as the number of trips of each collection unit. The actual miles traveled is a better unit.

(c) Collections Made. The number of houses (or possible points of collection) as well as the actual houses served should be recorded as it relates the collection unit to a measure of output or work done or service rendered. The record of complaints may be included here.

There are, of course, other less important items to record, most of which can be included under one of the foregoing three elements. Among these are the quantity of gasoline and oil, the amount of feed for horses, vehicle repair items, new tires, time of unloading, character of refuse, weather conditions, etc.

It is quite the usual practice to record the bulk of refuse handled in tons or cubic yards. Less frequently the distance traveled is recorded. With speedometers so adaptable there should be little difficulty in recording the mileage of each collection unit. There are very few cities where the "collections made" are of record. One of these is at Birmingham, England, where James Jackson, Cleansing Superintendent, has an excellent route system for recording the work of the collection units in terms of houses visited or collections made. In some places costs are computed on a per capita basis, but this does not measure actual work in rendering service.

The writer, however, believes that a

record of the service as measured by the collections made is of great importance and of inestimable value in comparing the work and service of similar communities and of collectors in a given community. This element, taken with those of bulk and distance, completes the measure of a collection service. Thus the number of pick-ups or collections made per hour is a useful measure of the work of a collection unit. In normal summer weather, with cans at the rear door, no alleys, good pavements and a normally well built up district largely of single houses on 50 to 100-foot lots, a good collection unit should work along its routes at the rate of about 40 to 50 garbage collections per man per hour.

Cost Records.—Cost records should, of course, be kept as well as service records. The total monthly cost should be divided into a few major items such as labor, gasoline and oil, repairs and the like. These should then be tabulated and charted in the several units given above as the cost per ton, per ton mile and per collection made. If such tables and charts include the total expenditures and the number of units (tons, miles, etc.), as well as the unit cost, they will serve as summary tables for the use and guidance of the executive department.

Route Maps.—Single large scale maps of each collection district showing house numbers are useful. The routes to be traveled by each collection unit should be marked as illustrated on the map (see cut at end of paper). The collector should follow these routes and upon reaching the place of final disposal after each trip, he should report the last house from which a collection has been made together with a note of any difficulties or houses not served. The record clerk would then assume that all other houses up to this point had been served. If a complaint is later received, it is either unfounded or the collector is at fault. The position of the collection unit along its route is also indicated and if he is falling behind he can be given assistance and later his routes shortened or changed. The attached Truck Progress Sheet shows how the record of "collections made" can be kept in this way.

Summary Records.—There are many record sheets in use for the bulk collected and none is shown here. However, a column should be included somewhere to show the miles traveled. As columns in a monthly sheet, the following headings are suggested:

(a) Collection Unit (Number).
(b) Trips or Loads.
(c) Tons.
(d) Miles.
(e) Ton-Miles.
(f) Collections Made.
(g) Pounds per Collection Made.
(h) Collections Made per Load.

Such records should be totaled each month and the totals divided with the total cost to give unit costs of work and service.

COMPLAINT NO
CALL

LOCATION _____
DATE _____ DIST NO. _____
COMPLAINT _____
REPORT
TIME COLLECTION MADE _____
QUANTITY COLLECTED _____
COMMENTS _____
SIGNED

COMPLAINT NO _____
Special Investigation

LOCATION _____
DATE _____ DIST NO. _____
COMPLAINT _____
REPORT
DATE _____
YOUR REPORT MUST COVER THE ABOVE COMPLAINT
NAME OF PARTY INTERVIEWED _____
INVESTIGATOR _____

Complaints.—The number of complaints received is a fair index of the efficiency of the service. Complaints should be recorded and given prompt attention. A form for recording complaints is shown on the following page. Such a complaint slip can be made up in blocks so that triplicate copies can be made by using carbon paper. Preferably each copy should be on differently colored paper. One copy is filed by the receiving or complaint clerk, one is put on a hook where it is picked up by an emergency or complaint collection unit, and one copy is given to the collection unit on whose route the complaint originated. The emergency unit should pick up it slips at noon and in the late afternoon or early morning, so that morning complaints are handled the same day and afternoon complaints before noon of the following day. The emergency collection unit chauffeur should make his report on his copy of the complaint slip and the chauffeur of the regular collection unit on his, and these two should be filed with the original. Where complaints are of such a character as to justify a special investigation, the results should be recorded on a special form as shown.

Annual and Monthly Reports.—The use of monthly and annual reports is twofold—(a) to inform the executives and heads of departments of the local government how the collection service is going and (b) to inform the local public and those interested from other cities. If routine operating records are kept, there should be no difficulty about the preparation of the reports. Thus the basis of good service is the routine record of operation.

Acknowledgment.—The foregoing paper was presented by Mr. Greeley at the 9th Annual Conference of the International Association of Street Sanitation Officials.

Missouri Conference on Water Purification

The fourth and most successful Missouri Conference on Water Purification concluded its meetings at Hannibal, Mo., Nov. 17. Interest in the program was evidenced by unusually good attendance of the 75 members and guests present, as well as lively discussions following the presentation of all papers.

Several changes were made in the constitution of the conference. The name was changed to Missouri Water and Sewerage Conference in order to indicate the present scope of interest including municipal sewerage as well as water systems. Provision was also made to accomplish affiliation of the Conference with the Federation of Sewage Works Associations.

The time and place of next year's meeting will be determined by the incoming Executive Committee. Following are the officers elected for the ensuing year:

Chairman, C. E. Heflin, Water Commissioner, Cameron, Mo.; Vice-Chairman, S. J. Duncan, Superintendent Waterworks, Moberly, Mo.; Secretary-Treasurer, H. D. Peters, Assistant Engineer, State Board of Health of Missouri; Executive Committee, W. V. Wier, Assistant Manager, St. Louis County Water Company, University City, Mo.; E. E. Wolfe, City Chemist, Hannibal, Mo.; W. P. Britain, Superintendent Waterworks, West Plains, Mo.; J. N. Wells, Superintendent, Joplin Water Works Co., Joplin, Mo.

Berlin Plans $96,000,000 Merger of City Railways.—The City Council of Berlin has decided to merge the city's vast transportation systems, comprising subway, elevated, motor bus and surface cars, into one undertaking with a capitalization of 400,000,000 marks (about $96,000,000). The new system will be known as the Berlin Transportation Co.

Cross-Connections Between Potable and Non-Potable Water Supplies

Final Report of the Committee of New England Water Works Association

SOME time ago the New England Water Works Association appointed a committee to make a study of cross-connections and to submit a report thereon. The committee consitsed of Robert Spurr Weston, chairman, John S. Caldwell, E. Sherman Chase, secretary; Stephen DeM. Gage, Chas. D. Howard, Arthur C. King, H. O. Lacount, Warren J. Scott, Stephen H. Taylor, and Arthur D. Weston. At a meeting of the association on Dec. 12 the committee presented its final report. The report, with the exception of the preface and the appendix, follows:

Definitions.—By a cross-connection is meant a connection between the distribution system of a public or private, potable water supply and a private or secondary, non-potable water supply.

One common example of a cross-connection is that between the public water supply of a municipality and the auxiliary fire-hydrant or sprinkler supply of a mill or factory,—the former sufficing for ordinary uses and the latter for fire fighting only. Another frequent case is where under ordinary conditions the public supply is taken for drinking purposes and for use in toilets and lavatories only,—water for all other purposes being taken from the secondary industrial supply. In a third common instance, water for various industrial processes, including boiler-feed water, as well as drinking water and water for toilets and lavatories, is taken from the municipal source, leaving the industrial source for private fire supply and miscellaneous industrial uses.

Connections are usually made through piping and gate-valves, with or without accompanying check-valves. Check-valves vary in type from simple, single, iron check-valves, with a swinging clapper, operating against an unfinished iron seat, to elaborate double, bronze, check-valves, like those devised and specified by the Associated Factory Mutual Fire Insurance Companies. The former are not precisely machined to prevent leakage, are usually rendered inaccessible by being buried in the ground, and are liable to rust so that the free movement of their clappers is obstructed. The latter are of excellent workmanship, are usually set in pits, or where they are accessible for inspection at all times, and are built of non-corroding bronze with rubber-on-bronze seats. This type of valve is equipped with gages and test cocks. (See accompanying figure on page 26.)

The Demand for Cross-Connections.—The principal demand for the establishment of cross-connections comes from fire insurance companies and from property owners who desire two rather than one source of water supply in order that there may be additional protection to life and property. Opposition to cross-connections has come principally from the health and water-works authorities, largely because numerous epidemics of disease have been traced to these connections.

Industrial Use.—Many large industrial plants and public utilities require a constant supply of water for boiler feed, for cooling purposes and for various manufacturing processes. To insure continuous operations, some secondary standby supply, instantly available in emergency, must be provided.

It is usually prohibitive in cost to purchase public water for ordinary uses and at the same time to store a supply of potable water sufficiently large for probable emergencies. Some way of using both the public supply and a secondary supply when needed is a practical necessity.

Fire Protection.—The automatic sprinkler has made it possible to concentrate with safety enormous values in industrial plants, mercantile buildings and warehouses. The manufacturers of the country have utilized this advantage to such an extent that adequate fire protection is now a necessity for the profitable continuance of their business. It is doubtful if the industrial development of this country could have been so extensive without the safeguarding influence of automatic sprinklers.

A good public water system is the very best primary supply for automatic sprinklers, and there is usually no practicable way of providing an alternative primary supply that is the equivalent of a good public water system. Even large elevated tanks storing water from the public supply and erected at great expense are necessarily of limited pressure and capacity. But municipal water supplies alone cannot be depended upon in all cases, for two reasons:

1. Fire will not wait in case the public water supply should happen to be out of service. If the tremendous advantages of automatic sprinklers in extinguishing fires at the start are to be realized, there must be pressure always on the sprinklers.

The Associated Factory Mutual Fire Insurance Companies have recorded about three hundred instances in which public water supplies have failed or been interrupted. In twelve of these instances fire broke out simultaneously with the interruption of the water supply.

2. Public water supplies are frequently inadequate in volume and pressure for the large number of automatic sprinklers and hose streams that might be needed to cope with a serious fire.

Therefore, whenever the value protected, or the fire or life hazard involved, is sufficiently great, a secondary supply is needed in order that automatic sprinklers shall control a fire at the start. The labor laws of New York State permit double the number of employees in buildings equipped with sprinkler systems.

It is often impracticable to provide a secondary supply of potable water of sufficient capacity to assure a volume of water adequate for an emergency, such as an unusually severe fire or a conflagration. Secondary supplies, of non-potable water, however, can be obtained in sufficient volume by utilizing open bodies of water, such as ponds and rivers. A cross-connection is at present the only practicable method of combining existing potable public water systems and available non-potable secondary supplies of large capacity, both automatically feeding into a common fire protective system capable of meeting the demands of sprinklers and hydrants during the progress of a fire. Such cross-connections, in order to function instantly when fire occurs, cannot be dependent upon manual operation but must be automatic.

Cross-Connections and the Public Health.—The following is a brief abstract of twenty-five instances on record where outbreaks of disease have been brought about by pollution of drinking-water supplies through cross-connections.

In nineteen of these instances the cross-connection contained a single gate—or check-valve. It must be borne in mind that a gate-valve is not an automatic device and that is affords no protection unless closed. In three instances, protection against mixing of unsafe with safe water was afforded by two gate-valves or by a check-valve and a gate in series, and in one instance there were two gate-valves and a check-valve in series on the cross-connection. In one instance, it might be assumed from the wording of the published record that protection against pollution was afforded by two gate-valves and a double check-valve arranged in series, although this was not definitely stated. In another case this condition was defi-

nitely stated. It is also true that one of the double check-valves that failed was of inferior type and that one had not been inspected recently.

In addition to the list of recorded cases of sickness or death due to pollution entering drinking-water systems through cross-connections with unsafe water supplies, the Conference of State Sanitary Engineers and several sanitary authorities have listed a considerable number of cases where trouble was caused by the introduction of polluted water through leaks in emergency intakes or by similar causes. The report of your committee, however, is limited to the effect of cross-connections, important as the other sources of danger may be.

Position of the Public Health Authorities.—While from the broad economic standpoint it may be undesirable to run the risk of fire losses and, possibly, some losses of life by accident to firemen and industrial employees in order to avoid the hazard of sickness and death due to the existence of cross-connections, the saving of life rather than of money must always be the dominant motive for sanitary authorities. The following may be given as examples of the reactions of sanitary authorities to this danger.

The position of New Hampshire is as follows:

"As a historical preface, it can be stated that this matter has been receiving consideration by the New Hampshire Board of Health for more than a dozen years. Attempts at reform had their inception when, as a result of some bad conditions discovered, a legislative bill was introduced which sought to prohibit the existence of any connection on a public water supply through which polluted water might be introduced therein.

"The opposition at the time of the industrial interests was so intensely manifested and the impossibility of establishing a flat prohibition was so obvious that this department next proceeded to consider the special safety devices that were then available. Manufacturers were advised that the situation involving single cast-iron check-valves, usually buried in the ground and commonly not even known to the water-works management, could not be permitted.

"A few of these manufacturers then proceeded to install special type double checks but most of them continued to 'stand pat,' or, while promising, to follow a procrastinating course. This they were able to do (1) because of the absence of any legislation and (2) because of the lack by this department of any adequate inspectional facilities.

"In 1919 a law was enacted prohibiting the maintenance of a connection of this character, except such as might be approved by the state board of health. There was included a proviso that 'every valve, gate or other device for controlling or preventing the inflow of water of unapproved character into the public supply shall be of such construction as to permit of efficient inspection and testing, and at actual test thereof shall be made not less than twice annually by the individual, corporation or association furnishing water to the public.'

"A beginning was then made toward the eradication of the single iron checks and manufacturers, in response to their inquiries, were advised that the least that could be accepted was the device as now commonly in use, suitably installed in a test pit. At the present time 67 New Hampshire mills have these double-check connections.

"Although recognizing that the ideal situation is one involving no connection whatsoever between a public water supply and a polluted industrial source, yet, with us it is a case of doing the best thing possible in view of existent facts. While admitting that no such device affords an infallible means of protection, yet it also cannot be denied that no form of protective action against a polluted water supply can be said to be infallible, these depending, as all of them largely must, upon the human factor.

"Accordingly, it is the present policy of the New Hampshire Board of Health to permit, for the purpose of fire protection only, of the use, in lieu of mechanical severance, of a suitable connecting device of the best approved type, providing also that such be installed in a proper test pit, and maintained under periodic inspection."

In December, 1926, the Rhode Island State Board of Health, while without authority to prevent the installation and use of cross-connections, adopted a resolution advising that all such be abolished.

In its bulletin of January, 1927, the Connecticut State Department of Health published an article by the Director of its Bureau of Sanitary Engineering. In this article, the author cites the regulations of the department, namely, that after Dec. 31, 1926, no cross-connections shall exist between potable and non-potable supplies, except that installations protected by double check-valves of approved type with adequate facilities for testing that were in existence on Dec. 31, 1926, may be temporarily continued with the approval of the State Department of Health. The latter provision was inserted because it was felt that double check-valves of the latest approved type should be given a fair trial. The length of extension of time granted will depend upon investigations that the department is now making as to the efficiency of the newest types of valves. No new installations of double check-valves are allowed.

In New York State the Public Health Council of the State Department of Health adopted on Nov. 12, 1925, an amendment to its sanitary code which prohibited cross-connections between non-potable and potable water supplies after July 1, 1926. This regulation permitted the continuance of cross-connections where two gate-valves with indicator posts and two check-valves of the special design of the Factory Mutual Fire Insurance Companies or equal were installed, but such connections were to be discontinued after July 31, 1928. The regulation also permitted the use of dual water-supply systems where the auxiliary supply was delivered to an elevated tank, provided the connections were made through an open discharge pipe above the high-water line of such tank.

On June 27, 1928, the Public Health Council voted to grant a further extension of six months. On July 3, 1928, the Commissioner of Health sent a letter to water-works authorities throughout New York State saying that, as a result of the development of a special fire-pump chlorinator, it was the opinion of the department that the installation and proper maintenance of such a chlorinator would satisfactorily meet the requirements of the sanitary code. The letter further outlined certain conditions that were to be met prior to the approval by the department of such cross-connections. Among these conditions was one calling for the proper installation of all-bronze, double check-valves between the fire-supply system and the municipal system. A copy of the letter is given in Appendix G.

In New Jersey a new chapter (Chap. XIII) to the Sanitary Code, enacted by the State Department of Health on Sept. 18, 1928, reads as follows:

"Regulation 1: A physical connection shall be considered as any cross-connection, by-pass, valve, pipe line, auxiliary intake, or other similar device which permits or may permit any flow of water into an approved public potable water supply from any other water supply unapproved by the Department of Health of the State of New Jersey, or any source of water supply not fully treated in accordance with the terms of the provisions of the permit issued for or the rules and regulations governing the supplying of such water for public potable purposes by the Department of Health of the State of New Jersey.

"Regulation 2: That after April 1, 1929, physical connections shall not be permitted, except where such physical connections existing on April 1, 1929, include two all-bronze check-valves with rounded rubber facing, two gate-valves with indicator posts, or rising stems and drip cocks and gauges for testing, and such physical connection is located in a vault or pit of water-tight construction readily accessible for inspection: and,

"Provided, That the application for the continuation of such a physical connection is made to the local board of health having jurisdiction and is approved by such local board of health, the date of continuance may be tem-

porarily extended by the Department of Health of the State of New Jersey."

General Code of the State of Ohio, Section 1252-3:

"It shall be unlawful for any official, officer, or employee having in charge or being employed in the maintenance and operation of a public water supply and water-works system or for any other person, firm or corporation to establish or permit to be established any connection whereby a private, auxiliary or emergency water supply other than the regular public water supply may enter the supply or distributing system, unless such private, auxiliary or emergency water supply, and the method of connection and use of such supply shall have been approved by the State Department of Health."

Other states have made similar regulations but the above will suffice for illustration.

Action of the American Water Works Association.—The fire-protection division of the American Water Works Association adopted the following resolutions at Louisville, Kentucky, May, 1925:

"WHEREAS cross-connections between potable public water supplies and supplies from other sources have been the cause of a large number of outbreaks of typhoid fever and other water-borne diseases, and

"WHEREAS, check-valves and other similar protective devices cannot always be depended upon, be it

"RESOLVED, that no physical connection should be permitted between a potable public water supply and any other supply except as follows:

1. With another potable public supply.

2. With a potable supply which is regularly examined as to its quality by those in charge of the potable public supply to which the connection is made.

"This prohibition to apply to all piping systems either inside or outside of any building or buildings, and

"BE IT FURTHER RESOLVED, that definite programs should be inaugurated in each municipality to permanently eliminate all other connections.

Action of the Conference of the State Sanitary Engineers. — The following resolutions were adopted in 1926 by the Conference of State Sanitary Engineers:

"WHEREAS, cross-connections, auxiliary intakes and by-passes between potable public water supplies and supplies from other sources have been the cause of a large number of outbreaks of typhoid fever or other water-borne disease, and

"WHEREAS, check-valves and other protective devices, or notifying the public in the case of using water from a polluted source through an auxiliary intake or by diverting the flow around an integral part of a purification plant through a by-pass, cannot be depended upon to adequately protect the public from disease,

"BE IT RESOLVED, that no physical connections should be permitted between any potable public water supplies either through cross-connections, auxiliary intakes or by-passes and other supplies except as follows:

1. With another potable public water supply.

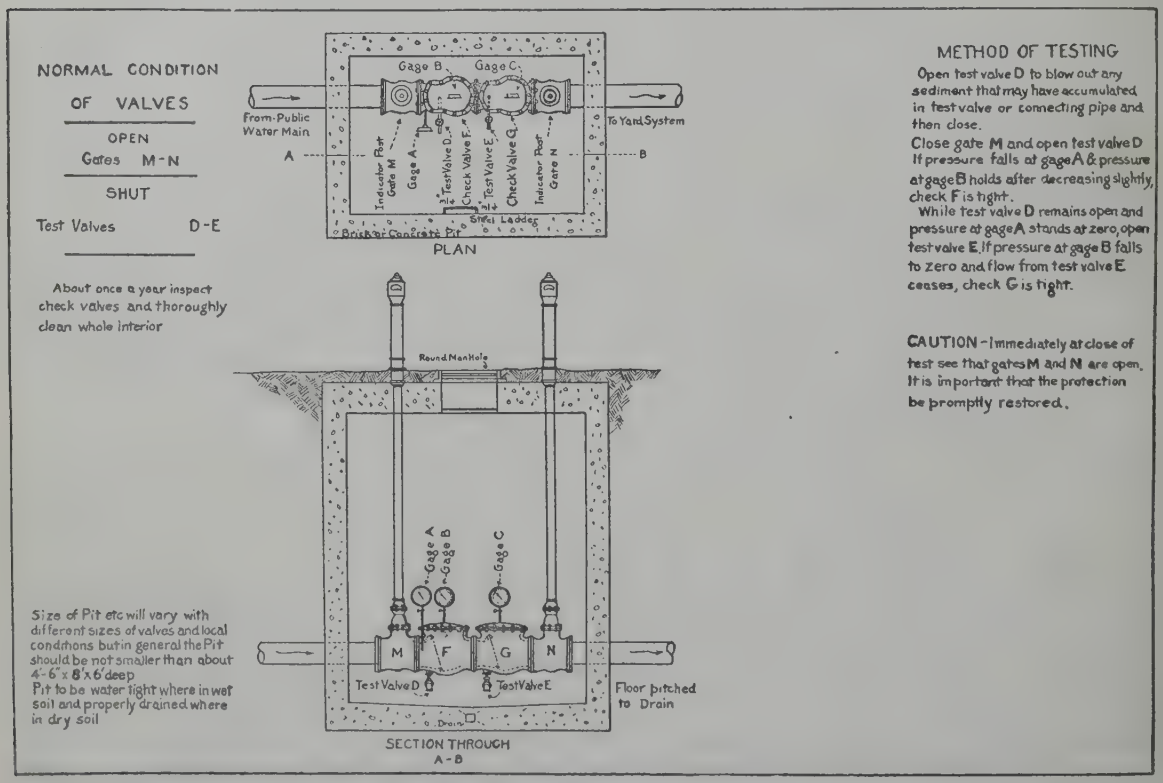
2. With a potable supply which is regularly examined as to its quality by those in charge of the potable public supply to which the connection is made.

"This prohibition to apply to all piping systems, either inside or outside of any building or buildings, and be it,

"FURTHER RESOLVED, that definite programs should be inaugurated in each state and each municipality thereof to permanently eliminate all other connections, and be it,

"FURTHER RESOLVED, that the Executive Committee of this conference transmit copies of this resolution to the Fire Underwriters Association and related organizations, also the American Water Works Association, New England Water Works Association and other analogous organizations with the request that they cooperate in securing the carrying out of the provisions of this resolution."

In its report which recommended this resolution for adoption by the Conference, the Committee defined cross-connections, auxiliary intakes and


NORMAL CONDITION OF VALVES
OPEN
Gates M-N
SHUT
Test Valves D-E
About once a year inspect check valves and thoroughly clean whole interior
Gage B
Gage C
From Public Water Main
To Yard System
A
B
Indicator Post Gate M
Gage A
Test Valve D
Check Valve F
Test Valve E
Check Valve G
Indicator Post Gate N
Steel Ladder
Brick or Concrete Pit
PLAN
Round Manhole
Gage A
Gage B
Gage C
M
F
G
N
Test Valve D
Test Valve E
Floor pitched to Drain
Drain
SECTION THROUGH A-B
Size of Pit etc will vary with different sizes of valves and local conditions but in general the Pit should be not smaller than about 4'-6" x 8' x 6' deep
Pit to be water tight where in wet soil and properly drained where in dry soil
METHOD OF TESTING
Open test valve D to blow out any sediment that may have accumulated in test valve or connecting pipe and then close.
Close gate M and open test valve D If pressure falls at gage A & pressure at gage B holds after decreasing slightly, check F is tight.
While test valve D remains open and pressure at gage A stands at zero, open test valve E. If pressure at gage B falls to zero and flow from test valve E ceases, check G is tight.
CAUTION - Immediately at close of test see that gates M and N are open. It is important that the protection be promptly restored.

Fire Service Connection Using Two Check-Valves—of Approved Type—Connecticut State Department of Health

by-passes; presented a tabulation of outbreaks of typhoid fever and in some instances of enteric diseases traceable to cross-connections, auxiliary intakes and by-passes. This tabulation includes a total of 8,028 cases of typhoid fever with 226 deaths and also more than 11,000 cases of enteric disturbances.

Appended to the report are the results of the questionnaire summarizing the procedure for elimination of cross-connections, etc. As an example of what may be done, the experience at Chicago may be cited. A survey disclosed 428 cross-connections of which 179 were direct and 249 indirect. By the end of 1925, 85.3 per cent of these connections had been removed.

Legal Liability.—The legal cases cited in the report of the state sanitary engineers support the position that municipalities that through their officers permit cross-connections with polluted supplies become legally responsible for any epidemics resulting therefrom. In the opinion of the Committee they become legally liable if the epidemics result from any negligence in the design, installation, operation or inspection of said connections. It is also true that equal, if not greater, responsibility rests upon state authorities regarding cross-connections even though it be moral rather than legal.

Relative Hazards.—In the 296 cases of interruption or failure of water supplies, recorded by the Association Factory Mutual Fire Insurance Companies, there were 12 cases where fires occurred simultaneously.

In the 8,028 cases of typhoid and over 11,000 cases of enteric disturbance, resulting in 226 deaths, the losses by death and disability reached millions of dollars. Most of the deaths followed pollution passing through single valves or checks.

Apparently no single valve on a connection between a potable and a polluted water supply affords sufficient protection, and even the best installation of double check-valves may fail for lack of inspection.

Importance of Inspection. — Where double check-valves are inspected frequently and where they are thoroughly overhauled annually, the danger due to cross-connections is greatly reduced. The permissibility of the best installation, other things being equal, therefore, hinges upon the frequency and kind of inspection.

Results of inspection of 1,032 sets of double check-valves by the Associated Factory Mutual Fire Insurance Companies showed only four cases where both valves were leaky, and in these four leakage was slight and due to lack of care. An instance has been cited*, however, where both clappers of a double check-valve installation were held partly open by a pair of overalls, thus again emphasizing the necessity for frequent inspection.

Data regarding cross-connections in New Bedford are of interest. Here the check-valves are inspected at least twice a year, and the results show both valves leaky in two out of 2,152 tests or less than one case in 1,000 inspections. Many of the installations were not of the latest type.

The results of the first year of periodical testing of double check-valves by the State Department of Health of Connecticut show that out of 624 tests on iron-body check-valves, there were 24 cases where one leaky valve was found and one case where both valves were found to be leaky because of unevenness in the flat, rubber seat-facings. Of 273 tests of the all-bronze valves, leaky valves (outside only) were found in 3 cases and in no case were both valves leaky.

In view of the large number of cases of sickness and death, the neglect of even the best devices is dangerous. No pains should be spared to make inspections thorough. The Committee realizes the difficulty in establishing a procedure that will prove effective for all conditions, all types of installation and all places. To indicate broad general principles rather than routine procedure seems to be the work of this committee. Nevertheless, it is believed that good results may be obtained by quarterly inspections. Furthermore, the Committee believes that, where possible, inspections should be made through the cooperative efforts of both state and municipal authorities on the one hand and the property owners and insurance companies on the other. Installations in each municipality should be examined by a state official or other competent water-works authority at least once a year.

The attention of water departments is called to the frequency of unknown and unprotected connections, not only as regards their existence but also as regards their type and condition. This relates particularly to old installations. All such connections should be sought out and, when found, should be abolished or protected.

The Committee appreciates the cooperation of the insurance companies as exemplified by the action of the Association Factory Mutual Fire Insurance Companies who are chiefly interested in the protection of factories and mills as contrasted with general fire protection. These companies at their executive meeting on Dec. 12, 1927, adopted the following procedure:

"a. See that every set of double check-valves, both old and new, receives the necessary supervision. Experience has shown that many risks do not appreciate the importance of keeping the double check-valves clean and tight by means of an annual overhauling. Our work would be in the line of education and assistance."

"b. Pending the decision in each case as to the final outcome, see at once that every single check-valve between potable and non-potable supplies is made accessible and kept tight as is being done in the State of Massachusetts."

"c. Make a study of fire-service connections at our plants both insured or prospective, and determine where it would be wiser to eliminate cross-connections and where best to provide other supplies. Then for those risks where cross-connections should be retained, have all-bronze double check-valves put in and provide for periodic and effective supervision of them as outlined in paragraph 'a' above."

As representing the attitude of other insurance companies the following may be quoted from a letter of George W. Booth, Chief Engineer, National Board of Fire Underwriters, published in the June 3, 1920, issue of the Engineering News-Record:

"The fire-protection engineer is not the responsible party in making the connection originally or in its continuance. Insurance standards require, for complete reliability, two independent sources of supply, and the plant management or the municipal authorities may, and often do, use one source which is unsafe or questionable from a sanitary standpoint, for the reason that it is a cheaper or easier one.

"The engineers of the National Board of Fire Underwriters do not, and we believe other engineers should not, favor such connections, but there are cases where they have already been made, and it is not possible, without the charge of discrimination, to refuse credit for them as emergency sources. It is, however, standard practice with many of the insurance bureaus to recommend secondary sources of supply which will be safe, as for instance, a storage reservoir.

"The double check-valve, designed some years ago for use on connections to sources of doubtful quality, has been permitted by some health authorities and has a satisfactory record. It should be installed most carefully and be maintained under a thorough inspection system."

Recent Developments in Chlorination.—A method of overcoming the dangers of cross-connections between safe and unsafe water supplies suggested in the past was to sterilize secondary supplies used for fire by installing chlorinators on fire-pump suctions. Fire pumps, however, are normally idle, being merely "turned-over" once a week to be sure that they are in operative condition; and once a year, during the summer, they are tested to capacity by means of hose lines attached to the yard hydrants.

A chlorinator attached to a fire pump, therefore, would normally be inoperative, and hence was not considered dependable, if called upon suddenly to operate in the emergency of a fire after having stood idle. Manu-

* Jour. N. E. W. W. A., Vol. XXVI, p. 406.

ally controlled chlorinators were also considered unreliable, because the operator of the pump, in the excitement of a fire, might forget to turn on the chlorine supply.

One manufacturer of water-works chlorinating apparatus has been at work on the problem, and has recently developed an automatic start-and-stop chlorinator, especially designed to be connected to fire pumps. This machine, which is of the vacuum type, utilizing liquid chlorine by reducing it to a gas, is so designed that a small auxiliary injector continually draws a small amount of chlorine gas and discharges it to waste, thus keeping the apparatus primed and assuring that it is always in operative condition. When the fire pump starts, a main injector draws the chlorine gas and discharges it in solution to the point of application of the fire-pump suction.

There is no need of proportioning the amount of chlorine exactly to the amount of water discharged, as is necessary in water-works practice, because the water delivered by the fire pump is not used for domestic purposes. The fire-pump chlorinator, therefore, discharges into the pump suction an amount of chlorine sufficient to care for the maximum draft from the pump, regardless of what is actually being delivered.

This chlorinator has been tested by the engineers of the New York State Department of Health. As a result of these tests, that department permits the retention of cross-connections under certain conditions, if chlorination is applied to the secondary supplies.

Conclusions.—The Committee recognizes that the only absolute safeguard for the purity of water supplies is complete separation of potable and non-potable supplies. Many cases exist in industrial as well as fire lines where cross-connections can be entirely eliminated without extensive changes or undue hazard to life and property. Such connections should be immediately abolished. In other instances the abolition of such cross-connections presents a very serious problem from the standpoint of possible loss of life and property by fire. Each case should be carefully studied on its own merits to determine the best procedure, all interests being considered. So far as possible steps should be taken in each community to provide public water supplies of sufficient adequacy and reliability, even to providing a secondary potable supply if necessary, so as to eliminate the necessity for cross-connections of any kind.

The Committee feels that pending the establishment of adequate and reliable supplies for protection of life and property from fire, experience to date indicates that double check-valves of the latest improved type, properly installed and adequately supervised, furnish the best protection of any single device now known. It is essential, however, that such installations be regularly and frequently inspected and tested. Installations of this type are relatively recent and whether or not such installations, give sufficient protection, is a question that is still open for decision on the basis of further experience.

The Committee is of the opinion that the recently developed chlorinator for auxiliary supplies offers another valuable means of defence against bacteriological contamination of public water supplies through cross-connections. However, the Committee believes that more experience must be gained with this device, before it can be unqualifiedly recommended. Properly operated and maintained, the device provides a method for making polluted auxiliary supplies, bacteriologically safe, even though such supplies might continue to be non-potable.

Your Committee does not approve the use of cross-connections between safe and unsafe supplies, and wherever auxiliary supplies are made safe by treatment there should be provided the additional safeguard of proper and properly installed and inspected double check-valves. Furthermore, these valves should be used between drinking water supplies and those that while unpotable,—like pure sea water,—do not require treatment to make them safe.

The Committee strongly urges that states adopt suitable laws and regulations covering the control of cross-connections and that in each community an investigation of the existing cross-connections be made immediately and a program for the elimination or control thereof be inaugurated by the local authorities. The Committee also urges that, where possible, the inspections be made through the cooperative efforts of state and municipal authorities on the one hand and owners and insurance companies on the other. Inspections of all installations of protective devices should be made at least quarterly by an official responsible for the quality of the public water supply and such devices should be overhauled yearly.

While this report is largely concerned with cross-connections for fire service, there are many other cross-connections like those with sewers, around water-purification plants and through auxiliary intakes. None of these should be permitted.

Your Committee recommends that the following resolution be adopted by the Association:

"WHEREAS, evidence shows that the existence of certain cross-connections between safe public water supplies and unsafe private water supplies, not equipped with modern protective devices, has resulted in many outbreaks of disease and many deaths, and

"WHEREAS, such cross-connections are a hazardous part of any water-supply system.

1. This Association recommends that no cross-connection be permitted with a supply that in the opinion of the State health authorities is bacterially unsafe.

2. This Association recommends that any cross-connection permitted with a bacterially safe but non-potable supply shall be made through a properly installed and adequately supervised, all-bronze, rubber-seated, double check-valve of a type approved by the State health authorities.

Ohio Sewage Treatment Conference

The second annual Ohio Conference on Sewage Treatment was held at Marion, Oct. 31, with attendance of about 100. Of the 85 municipal sewage treatment plants in Ohio, 41 were represented by one or more persons. There were also present a number of city officials having to do in one way or another with sewage treatment plant operation.

The program was to some extent diversified, the topic of sewer rental law and its practical operation receiving lively discussion. The latter portion of the afternoon was devoted to an inspection of the Marion sewage treatment works.

Officers elected for the ensuing year were: C. C. Hommon, Canton, chairman; G. E. Flower, Cleveland, vice-chairman; Floyd G. Browne, Marion, secretary-treasurer; F. E. Sheehan, Portsmouth, member-at-large of the executive committee.

No decision was made as to next year's meeting place, but a very cordial invitation was presented by the officials of Akron.

Mosquito Survey Under Way for Toledo, O.

A survey to find out what steps are necessary to rid Toledo of the mosquito nuisance has been started under the direction of Major E. M. Skinner of the mosquito control division of the Gorgas Memorial Fund.

The survey, which is being underwritten by the Toledo Chamber of Commerce, will include an investigation of polluted and stagnant pools and streams. When the survey is completed, the findings as to causes and an estimate of the probable cost of elimination will be presented to council. There is some possibility that the city and county might jointly finance the necessary expenditures to allow the people of Toledo and Lucas County to sleep in peace during July and August.

Boston Company Acquires Five West Virginia Utilities.—The Atlantic Public Utilities Corp., Boston, Mass., has purchased five water and electric companies in West Virginia. These are Weston Water Co., Glenville Electric Co., the St. Albans Water Co., the Dunbar Water Co., and the East Rainelle and Oak Hill Water Co.

Asphaltic Pavement Construction in the City of Pittsburgh, Pa.

Sub-Base Treatment, Base Proper and Top—Materials and Methods

By J. J. PAINE
Director, Pittsburgh Bureau of Tests

IN Pittsburgh we have hundreds of miles of good streets, and like every other large city, we have a few that are not so good. Pittsburgh has many difficult engineering problems and often a very short street will pass over sand, clay, shale, rock and filled ground with exceptional grades, and curves, along hillsides and ravines.

Causes of Failures.—Five years after the World War, we found a number of our streets breaking up. There were some unpleasant rumors. The contractors said it was due to poor materials, and the materials people blamed the cause on everything else. So we had an extensive investigation and numerous conferences.

Taking thirty streets that varied from one year to ten in age, our report was something as follows:

21 streets—poor workmanship and design.

7 streets—poor materials and design.

2 streets—poor inspection and design.

In every case we see design as one of the contributing causes. Our Engineering Bureau in Pittsburgh has as many capable and competent engineers as any city in the country. We were following standard practice for that time. Careful preparation of the sub-grade; a 6-in. 1:3:6 concrete base, with a standard block stone, brick or asphalt top.

Now please do not jump to conclusions. I am talking about heavy traffic streets. We have numerous residential streets built on this method, 15 years or more old, and still giving excellent service. Also allow me to explain more at length the nature of these failures.

Base Failure Due to Heavy Loads.—In 90 per cent of the cases, the cause was base failures; the pavement had worn out from the bottom up, rather than from the top down. The street had failed under the terrific demands of increasing traffic. We also noted, that in nearly every case where there was a failure, that the sub-grade had sunk, shifted or in some way changed from its original contour. I might add, that at this time, there were hundreds of solid tired trucks hauling coal, steel, gravel, cement, etc., with loads of from 10 to 15 tons and some even higher. At present we are trying to limit tonnage and make all trucks use pneumatic tires.

Experiments conducted by our laboratory indicate that the impact of a truly solid wheel tire varies in force in approximately the same ratio as that of the force imparted by a free falling body. Thus we see that heavy solid tired trucks, having chains on, will give continuous impacts of from six to eight times its dead load, per rear wheel. Often these stresses set up in a pavement are above the strength of the materials and unless properly distributed the result is failure of the pavement.

For the last ten years many of us have been attending concrete, brick, asphalt, and other association meetings all over the country and it is only on rare occasions that we ever hear someone suggest that a proper foundation should be put under a pavement. That is supposed to be an axiom but in many cases, I find it to be only a postulate. We discuss this and that kind of pavements, extol its virtues, and go along our way as if it can be placed on thin air. Perhaps there is little discussion of sub-grades and sub-bases, because there is no association in their behalf, but I believe it would be well for representatives of different associations and material salesmen, to study, design, and work out for their respective districts and communities the proper kind of foundations for local conditions and materials; it would often save many embarrassing explanations and excuses for failure of their materials.

Sub-Grade Preparation.—So if we are going to make any real attempt toward constructing an Ideal Pavement, the first thing to be considered is the foundation. We speak of adequate drainage. The drainage facilities should always be more than adequate. Next, proper preparation of the sub-grade. Unless the sub-grade is thoroughly stable, that is, will resist temperature and moisture changes under all conditions, it has not had proper preparation. A sub-base treatment should then be resorted to.

In the Pittsburgh district the sub-soil is principally clay. On account of the fact that clay soils have certain undesirable characteristics as regards their behavior under influence of moisture and temperature, they cause much trouble in pavements which are laid on them. This holds true regardless of the type of pavement. Consequently, many experiments, with stone, gravel, and slag, have been tried in order to find some way of eliminating or at least conteracting or reducing these harmful effects.

One way is the use of a cushion blanket of granulated slag 3 or more inches deep. This method seems fairly successful when held between curbs.

Another method is to mix a granular material with the clay instead of compacting it in a layer over the clay. I refer to the method developed by Prof. H. Eno of Ohio State University. Also, A. T. Goldbeck, 1924, American Association of State Highway Officials.

In the past we used a rather coarse aggregate ranging from 1½ in. to 3 in. The aggregate was placed in two layers with a total thickness as shown on the contract plans, which is ordinarily 3 in. in thickness. The first layer is thoroughly rolled in to and incorporated with the sub-grade. The second layer is then spread and rolled until creeping before the roller ceases and all the material is locked or keyed. After this second rolling the voids in the top layer are filled with aggregate ranging from ¼ in. to ¾ in. and thoroughly consolidated by rolling.

More recent experiments with hard air cooled slag have given excellent results. The principle involved here is exactly the same as that in the construction of so-called "traffic bound" roads. This principle is that of increasing the internal friction in the sub-base and hard air-cooled slag is apparently giving the best results; this is probably due to the rough surface texture of the slag particles which must necessarily give greater friction than would smooth surfaced particles of the same size.

The advantages of a sub-base treatment are several. First, it gives a permanent even and uniform solid foundation. Second, it can be cut into if necessary and again repaired without great difficulty. Third, it forms an effective drain whereby the water may be carried to the curb drains and prevent saturation of the base. Fourth, it forms a moisture barrier between the sub-soil and base and prevents continued transmission of moisture by capillary attraction. Fifth, more uniform conditions, with especial relation to moisture. Six, increased bearing power which helps to distribute stresses and absorb heavy impacts.

The Base.—The base proper, which is usually concrete or reinforced concrete, needs but little discussion at this time as all engineers are familiar with the latest methods of design and construction. However, I wish to state that I am not in sympathy with local

mixes. Anything leaner than a 1:6 (approximately 1:2:4) mix has proven extremely unsatisfactory in Pittsburgh. Also, without going into the mechanics and mathematics of the problem, I believe that nothing less than an eight in. base should be used for heavy traffic streets.

Perhaps, in the next few years, we may see considerable changes in the base types. A base that is rigid, strong, resistant to moisture, more free from expansion and contraction stresses, yet more flexible, and easier to cut into and repair.

Slag Aggregate for Binder.—In Pittsburgh, we have a decided preference for sheet asphalt as the result of many experiments and practical experience. The usual 1.5 in. binder and 1.5 in. wearing courses are used. The coarse aggregate for the binder course is slag, having the following requirements: Slag shall consist of air cooled blast furnace slag of clean, tough, durable pieces, non-glassy in character. Dried slag when tested according to the methods of the American Society for Testing Materials, Serial Designation, C 29-27, shall weight not less than 70 lb. per cu. ft. All the material must be retained on a 10 mesh screen.

At least 25 per cent shall pass a ⅜ in. circular opening; at least 30 per cent and not more than 50 per cent shall pass a ⅝ in. circular opening and be retained on a ⅜ in. screen; at least 90 per cent shall pass a 1-in. opening; and 100 per cent shall pass a 1¼-in. circular opening.

We have found slag to be the most satisfactory of all our local materials and have between 300 and 400 miles of binder laid with this material.

The bulk of our sand has been a well graded silica lake sand.

The Filler.—The filler has been limestone or silica dust. For the last five years we have obtained very satisfactory results with silica dust, a by-product from glass plants. We have used this as a filler up to fairly high percentages. Its grading is approximately as follows:

	Per Cent
Passing 300 mesh sieve	81.5
Passing 200 mesh sieve	90.0
Passing 80 mesh sieve	98.0
Passing 50 mesh sieve	100.0

All asphaltic cement used met the regular standard specifications.

The Binder Mixture. — The binder composed of coarse aggregate, sand and asphalt was mixed in approximately the following preparations:

	Per Cent
Asphaltic cement	4.0 to 6.5
Fine Aggregate	20.0 to 35.0
Coarse Aggregate	58.5 to 76.0

With at least 25 per cent of the fine aggregate retained on a 40 mesh screen.

With at least 25 per cent of the fine aggregate retained on a 40 mesh screen.

Oftentimes there seems to be a tendency towards laxity when preparing and laying binder, but as much care in the preparation and placing of binder should be exercised as in that of the wearing course. Design of mix, temperatures, raking, compression, thickness, and even contour should be carefully adhered to. The binder is not just a filler to bring the streets to established grade; it is a foundation, and unless there is a definite bond between the binder and the base, and the binder and the top, it is not fulfilling its purpose.

This year the City of Pittsburgh definitely adopted the high dust filler and void theory of design for wearing surface on heavy traffic streets. Our mixture contains the average preparations as follows:

	Per Cent
Bitumen soluble in carbon tetrachloride	8.5 to 10.5
Bitumen soluble in carbon tetra-4....	NU NU U
Dust passing a 200 mesh screen	18.0 to 30.0
Sand passing a 80 mesh screen	15.0 to 25.0
Sand passing a 40 mesh screen	20.0 to 35.0
Sand passing a 10 mesh screen	15.0 to 25.0
Sand passing a 4 mesh screen	0 to 5.0

Preparing Wearing Surface. — Our specifications for preparing and laying wearing surface are as follows:

The sand and asphalt cement shall be heated separately. The temperature of the asphalt cement shall be maintained between 300 and 350 F. at the discharge pipe. The temperature of the sand in the mixer-box and after adding the filler, shall not exceed 450 F. Specified proportions of filler and hot sand, determined by weight, shall be immediately mixed in an approved mixer. Then shall be added the hot asphalt cement in the stipulated proportions and the whole mixed for at least one and a half minutes or long enough to effect a thoroughly homogeneous mixture.

In preparing the wearing course mixture in a pug-mill mixer, the combined weight of mineral aggregates, including filler plus asphalt cement, shall not produce a volume of material in excess of that which will find its normal level in the mixture-box slightly below the top of the mixer blades when said blades are exactly vertical.

Laying Wearing Surface.—Upon the binder course shall be laid the wearing course as described below.

The asphalt wearing surface shall be hauled to the work in trucks equipped with canvas or other suitable covers and shall leave the plant at a temperature of between 375 and 425 F. as suitable for the asphalt used and air temperature. Upon arrival at the street, it shall be deposited at least 10 ft. ahead of the work, upon the clean binder or a movable platform from which all mixture shall be distributed to the place where it is to be raked. The temperature of the mixture shall be not less than 350 F. The shovelers shall carry each shovelful to its place, in front of the rakers, and turn it over as deposited. Rakers shall not be allowed to walk in the hot mixture. The hot mixture shall be uniformly distributed and thoroughly raked to full depth upon the asphaltic binder (which shall be thoroughly dry, free from leaves or other foreign matter) so that after receiving its ultimate compression by rolling, it shall have an average thickness of 1.5 in. Any material that is lumpy or does not break down easily must be wasted. Immediately after the mixture is raked it shall be luted transversely of the pavement by means of a lute 5 to 6 ft. long, operated from the sides of the pavement. Strokes with the lute shall overlap each other at least 2 ft., and shall extend beyond the center of the pavement. The initial compression shall be effected by means of a three wheeled roller, weighing not less than 12 tons, used longitudinally to the pavement, after which a small amount of portland cement shall be swept over the pavement. Rollers must get on to the work as soon as practicable. Final compression shall be effected by means of a tandem roller weighing not less than 10 tons. Rolling shall be steadily kept up at the rate of not more than 200 sq. yds. per hour until all roller marks shall have disappeared and the surface gives indications of no further compressibility, and free from elevations and depressions more than ¼ in. under a 6 ft. straight edge placed longitudinally to the pavement. Roller paths shall at all times overlap by half the width of the roller.

The mixture after final compression shall show a density by the specific gravity method of not less than 85 per cent of the specific gravity of the mineral aggregates contained therein.

The mixture shall average not less than 155 lbs. per sq. yd. of surface.

No mixture shall be laid in the rain or when the binder has water standing upon it or when the weather conditions are unsuitable. Care should be taken to apply water to the roller wheels in just sufficient quantity to prevent hot mixture adhering, and with no excess so as to cause blistering. All blisters must be broken up with a rake or raked out and replaced with fresh material. Cross and diagonal rolling should not be undertaken until the mixture will stand same without checking and such rolling shall be done only with the tandem rollers.

The notion of the roller shall at all times be slow enough to avoid displacement of the hot mixture and any displacements occurring as a result of reversing of the direction of the roller or from any other cause, shall be corrected by the use of rakes and fresh material where required. For a radial distance of 8 in. around all structures, manholes, curbs, gutters, or other locations, inaccessible to the roller, the compression shall be effected with hot iron tampers weighing not less than 25 lbs. and having a bearing area not exceeding 48 sq. in.

The roller shall be weighed. The roller wheels shall be tested with a straight edge in order to detect untrue surfaces.

Badly worn bearings shall be replaced before the roller is used as a

defective roller will cause a wavy and untrue surface.

There shall be a positive bond between binder and top.

These are a few of the many details that must be constantly emphasized in asphaltic work.

Asphaltic Cement.—Our asphaltic concrete is of the familiar fine graded type having the following composition:

	Per Cent
Bitumen	5.5 to 7.5
Aggregate passing 200 mesh sieve	8.0 to 12.0
Aggregate passing 80 mesh sieve	6.0 to 15.0
Aggregate passing 40 mesh sieve	10.0 to 20.0
Aggregate passing 10 mesh sieve	10.0 to 20.0
Aggregate passing 3/8" screen	15.0 to 30.0
Aggregate passing 5/8" screen	5.0 to 20.0
Aggregate passing 3/4" screen	5 to 15.0

Screen: Circular openings.

The coarse aggregate used in the asphaltic concrete is slag as we have found this to be the most suitable of our local materials. We have many miles of slag asphaltic concrete which have given excellent service under heavy traffic for 10 to 15 years.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 7th Annual Asphalt Paving Conference held at New Orleans, La., Dec. 3-7, 1928.

Chemical Treatment at Kansas City

Method of Water Purification at City Plant Outlined

By GEO. F. GILKISON
Chief Chemist, Water Department, Kansas City, Mo.

THE Kansas City, Mo., water department takes its supply from the Missouri River. This is a highly polluted surface supply, carrying a large amount of suspended matter.

Suspended Matter.—The suspended matter in the Missouri River varies over a very wide range, both with regard parts per million and coefficient of fineness. The turbidity of this stream varies from 15 parts per million in the winter, when the river is frozen over, to 18,000 parts per million in the spring, when the ice breaks up. The coefficient of fineness of suspended matter varies from 0.8 to 1.5, based on the A. P. H. A. standard.

Dissolved Solids.—The concentration of dissolved solids also fluctuates, varying from 300 parts per million in the spring when the river is high, due to snow water from the upper watershed and spring rains over the lower portion, to 540 parts per million when the river is at its lowest level in the winter. The Missouri River watershed covers approximately 430,360 square miles.

Color.—The Missouri River carries very little dissolved coloring matter, and at no time of the year is it a factor in computing the required chemical dose.

Hardness.—Ours is a comparably hard surface supply. The total hardness varies from 148 parts per million to 296 parts per million, expressed in terms of calcium carbonate. The average total hardness for the past year was 219 parts per million, of which 148 parts per million were due to calcium and magnesium bicarbonate, and 70 parts per million to calcium and magnesium sulphates.

B. Coli Index.—The B. Coli index of the Missouri River is very high at Kansas City, ranging from 50 per 100 c.c. to 100,000 per 100 c.c. completely confirmed.

Industrial Waste.—This division is indeed fortunate that, with all the industrial waste being discharged in the Missouri River, none of them, to date, had directly or indirectly interfered with our purification process. The characteristic odor and taste of chlorine, that you have doubtlessly all noticed in our city water supply, cannot truthfully be charged to industrial waste, but is the direct result of trying to maintain open storage basins in our industrial districts.

Chemical Treatment.—The chemical treatment at Kansas City consists of presedimentation, followed by coagulation with alum and lime, and sterilization with liquid chlorine.

Presedimentation.—With a raw supply carrying as high as 18,000 parts per million turbidity, it necessarily follows that presedimentation is an important step in purification here. At the Quindaro Purification Works the raw water is pumped into a 4,750,000 gal. basin, known as the horseshoe basin, or basin No. 1. It flows from this basin into basin No. 2 over a weir, in front of which is a stilling baffle. This basin has a capacity of 14,250,000 gal., making a total of 19,000,000, which is 4½ hours retention, based on 100,000,000 gal. daily pumpage. These basins are flushed regularly, but nevertheless they soon fill up with sludge, necessitating their being cut out of service and washed. Three hundred and thirty thousand six hundred and sixty-five tons of suspended solids were removed from the water in the Quindaro basins last year, 298,241 tons of which were removed in the preliminary basins, that is, 90 per cent of the basin load was carried by the preliminary basins. At the North Kansas City Purification Works we have four 4,000,000 gal. circular preliminary basins equipped with Dorr mechanical clarifiers. This gives four hours' retention, based on 100,000,000 gal. daily pumpage. This equipment provides for the continuous removal of the sludge, and eliminates the necessity of cutting units out of service for washing. The new North Kansas City Purification Works have been in service but a short time, and have been operating much below rated capacity. For this reason no attempt will be made to quote efficiency at this plant.

Application of Chemicals.—At the Quindaro plant the alum and lime are applied to the water through perforated lines as it passes over No. 2 weir; that is, as it passes out of the presedimentation basin. The water then enters a short mixing chamber, with a retention period not exceeding one minute. It then enters the coagulation basins, where it remains 17 3/10 hours, based on 100,000,000 gal. daily pumpage. It is chlorinated as it leaves these basins, and is pumped to the distribution station. No filters are provided at the Quindaro Purification Works. The average raw water turbidity for the past year was 3,100 parts per million, and the delivered water 10 parts per million, or an average of 99.68 per cent removal by sedimentation and coagulation alone.

Approximately 5,000,000 lb. of alum was used by the water department last year, all of which was manufactured by the department. The total cost of manufacturing alum for the past year was $16.22 per ton, delivered to the storage bin. The dose of alum varied from 4.26 grains per gallon to 0.58 grains per gallon, the average over the year being 1.67 grains per gallon. The lime used was lump quick lime, containing an average of 92 per cent water soluble calcium oxide. The dose used varied from 2.33 grains per gallon to 0.29 grains per gallon, the average for the year being 0.84 grains per gallon.

It will be noticed that the dose of lime is approximately one-half that of alum. This is the ratio we use most of the year. With an average hardness of 219 parts per million, it seems the addition of lime, purely for aiding coagulation, would be unnecessary, but experience has shown us that a much smaller dose of alum may be used, if approximately one part of lime is used to two parts of alum.

Chemical Cost.—The chemical cost of purification for the past year was $2.94 per million gallons, delivered to the city. This is the cost of chemicals alone, and does not include handling cost.

In view of the marked contrast in methods and equipment at the Quindaro and North Kansas City Purification Works, it is indeed unfortunate that enough operating data on the new plant is not at hand for comparison of efficiency and cost, but it is impossible to compute the efficiency of a hundred million gallon daily plant from the results obtained by operating it at one-fourth rated capacity.

Acknowledgment.—The foregoing paper was presented at the recent meeting of the Missouri Valley Section of the American Water Works Association.

The Sewage Treatment Plant of the Bloomington and Normal Sanitary District

How Two Illinois Cities Solved Their Sewage Disposal Problem

By CHARLES CARROLL BROWN
Associate Editor, Municipal News and Water Works

IN the earlier sanitary history of Bloomington, Ill., when it was perhaps half its present size, combined sewers were built, some of them by engineers who had the idea that open joints were preferable for such sewers, although the soil is the usual Illinois clayey loam with an occasional lense of more porous material. Perhaps as a consequence, straight grades were not thought to be necessary and it was reported that there were long pools of standing sewage in the system during periods of dry weather. The consequence of such pools was very evident at the untrapped storm water inlets and such manholes as have perforated covers. One engineer tried to cure the evil by inventing what he called a stench trap, which was a cast iron plate over a rectangular channel in the gutter at the catch-basin, with flap at each inlet from the gutter. The plate served as a gutter crossing for foot passengers at a street corner and the flaps were supposed to serve to retain the odorous gases in the sewer system. It is needless to say that the refuse brought to the catch basins by storm water propped open the flaps so that the neighbors complained bitterly of their inability to occupy their front porches on warm summer evenings.

In the years that have passed repairs to many sewers have removed some standing pools but that there are still some left is evidenced by the odors still given off at times through the untrapped storm sewer inlets, and by the dark color of the sewage delivered at the new sewage disposal plant, which was put in operation early last summer.

The Situation at Bloomington.—Bloomington and Normal are twin cities on the same drainage watershed and when sewerage and drainage conditions became troublesome in Bloomington it was manifestly unjust to put the whole cost of the main drainage system on the former city, through which Normal had its only practicable outlet. The situation was particularly troublesome to Bloomington because its water supply was obtained from wells in strata of porous material in the narrow drainage valley formed at and below the junction of two creeks which are the surface water drains and to some extent the underground water drains of Normal and of a considerable portion of Bloomington. These porous strata are at different depths and furnished various qualities of water, but those furnishing the best water were so near the surface that they were in danger of pollution by the slowly increasing sewerage system of Normal, whose only outlet is the stream mentioned.

Until 1917, however, nothing could be done officially to remedy conditions as to drainage and these two cities were among those active in securing the enactment by the legislature of that year of the Sanitary District Law of Illinois.

Formation of Sanitary District.—The Bloomington and Normal Sanitary District was established under this law in 1919 as the result of a vote of the taxpayers in the proposed district and much strenuous work by progressive citizens having the welfare of the cities at heart, and backed by the efforts of the State Department of Health with its experts, and others. The Trustees elected are John W. Harber and John J. Condon of Bloomington and W. W. McKnight of Normal, outstanding citizens of the district, having the full confidence of their constituents.

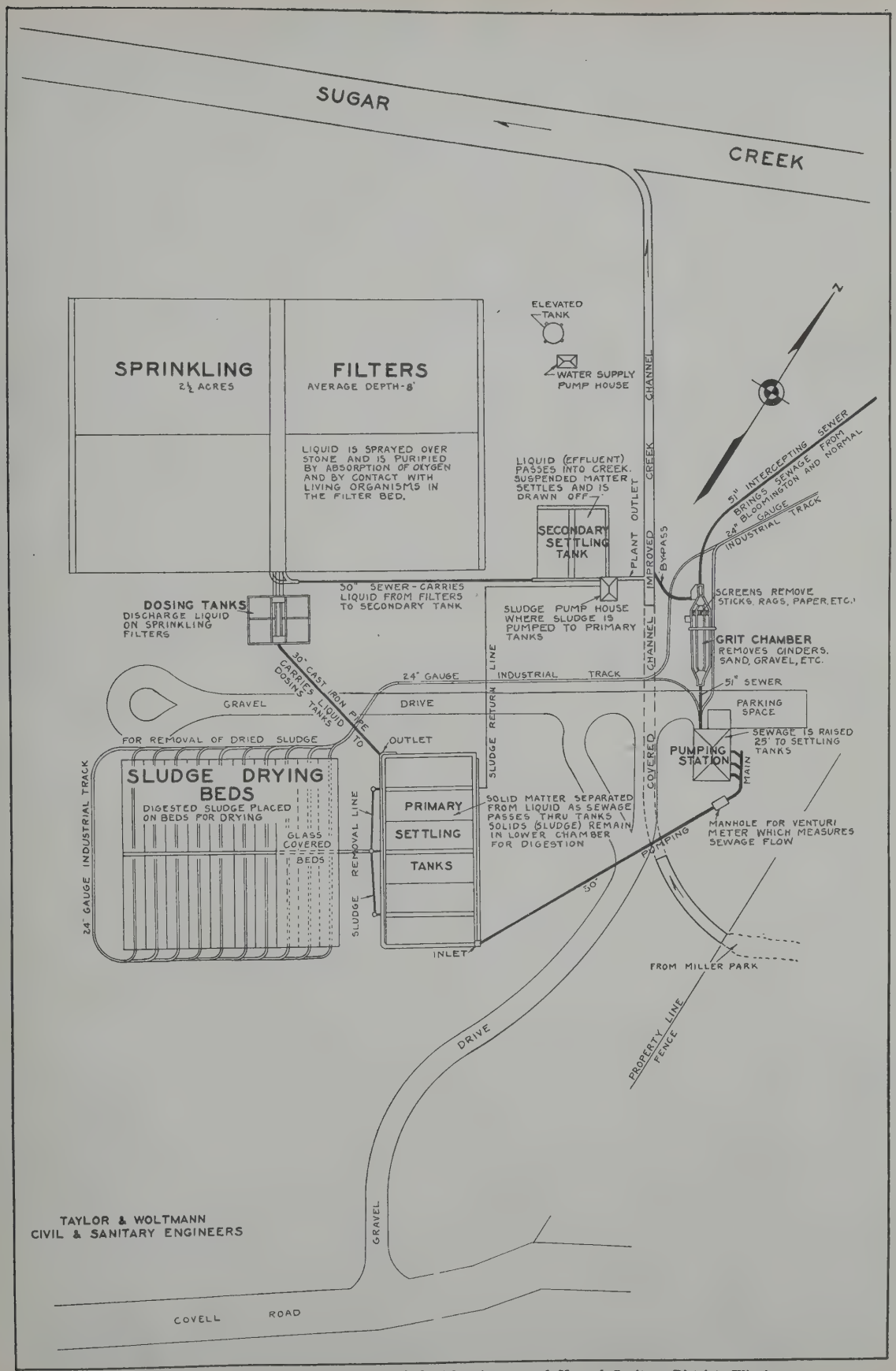
A preliminary study of the water pollution, sewerage and drainage problems of the cities was made by a well-known firm of engineers, which offered a full and promising solution for all of them but seems to have been more expensive than the citizens were willing to pay for.

The commissioners of the sanitary district took up the sewerage problem separately and now have their solution of it in what may be termed the trial stage of operation, and promising to be equal to others of the same sort under the same conditions, if not superior in some respects. They have done some necessary things toward the proper control of the surface drainage of the district and have attacked the problem of separating the sewage from the storm drainage in the existing combined sewers as well as by means of separate systems of storm drains and sanitary sewers in the newer parts of the cities.

The water supply problem is being attacked by a corporation formed by public spirited citizens who propose to secure a surface water supply, the cost to be borne by a bond issue of the corporation which will ultimately be taken up by the payment of rentals by the city and by the profits on water rates when the water works will become the property of the city. In this case the City of Bloomington will be the business operator and Normal will, if it chooses, become a wholesale customer, retailing water to its own citizens.

Design of the Plant.—A bond issue of $700,000 by the Sanitary District was voted in October, 1925, after some campaigning, with which to build the proposed sewage treatment plant and other works required in connection with it. Taylor and Woltman were selected as engineers, the former being a local engineer and the latter a young man of considerable experience in sewerage operations. They were given full opportunity to study their problems and to secure all the data thought necessary to make application of well established methods to the particular conditions at Bloomington. The result is a standard design including bar screens, grit chambers, pumping sewage up 25 feet through a Venturi meter to Imhoff-type primary settling tanks with upper story flow-through chambers dropping the settlings into digestion tanks or chambers below from which gases arise in the gas chambers to escape into the air or to be gathered and burned; sludge drying beds, dosing chambers distributing clarified sewage to sprinkling filters with broken stone as filtering material, secondary settling basin, small sludge pumping plant to pump sludge from secondary basin to primary sludge digestion chambers, the fully clarified effluent discharging through an improved concrete lined creek channel to Sugar Creek, a larger and as yet unimproved channel. The system need not be described in detail at this time except as to features which are peculiar to this plant and show how modern engineers modify standard practice to fit special conditions.

The accompanying diagram shows the direct flow of sewage and sludge by perhaps the shortest journey possible, entering from the north and flowing round the plant in the direction of the hands of a watch so that the treated and clarified sewage from the secondary settling basin enters the improved creek channel at a point opposite the short by-pass from the screen chamber; and the dried sludge is found at the south side of the plant at the most convenient place for removal, whether used for filling low ground about the plant or sold to farmers and removed by way of the road, which, by


SUGAR
CREEK
SPRINKLING
2½ ACRES
FILTERS
AVERAGE DEPTH-8'
LIQUID IS SPRAYED OVER STONE AND IS PURIFIED BY ABSORPTION OF OXYGEN AND BY CONTACT WITH LIVING ORGANISMS IN THE FILTER BED.
ELEVATED TANK
WATER SUPPLY PUMP HOUSE
LIQUID (EFFLUENT) PASSES INTO CREEK. SUSPENDED MATTER SETTLES AND IS DRAWN OFF
SECONDARY SETTLING TANK
PLANT OUTLET
IMPROVED CREEK CHANNEL
BY-PASS
51" INTERCEPTING SEWER BRINGS SEWAGE FROM BLOOMINGTON AND NORMAL
24" GAUGE INDUSTRIAL TRACK
30" SEWER - CARRIES LIQUID FROM FILTERS TO SECONDARY TANK
DOSING TANKS
DISCHARGE LIQUID ON SPRINKLING FILTERS
SLUDGE PUMP HOUSE WHERE SLUDGE IS PUMPED TO PRIMARY TANKS
SCREENS REMOVE STICKS, RAGS, PAPER, ETC.
GRIT CHAMBER
REMOVES CINDERS, SAND, GRAVEL, ETC.
30" CAST IRON PIPE CARRIES DOSING LIQUID TO TANKS
24" GAUGE INDUSTRIAL TRACK
51" SEWER
GRAVEL DRIVE
SLUDGE RETURN LINE
PARKING SPACE
FOR REMOVAL OF DRIED SLUDGE
OUTLET
SEWAGE IS RAISED 25' TO SETTLING TANKS
PUMPING STATION
MAIN
SLUDGE DRYING BEDS
DIGESTED SLUDGE PLACED ON BEDS FOR DRYING
24' GAUGE INDUSTRIAL TRACK
GLASS COVERED BEDS
SLUDGE REMOVAL LINE
PRIMARY SETTLING TANKS
SOLID MATTER SEPARATED FROM LIQUID AS SEWAGE PASSES THRU TANKS. SOLIDS (SLUDGE) REMAIN IN LOWER CHAMBER FOR DIGESTION
COVERED
MANHOLE FOR VENTURI METER WHICH MEASURES SEWAGE FLOW
PUMPING
30"
INLET
FROM MILLER PARK
DRIVE
PROPERTY LINE FENCE
GRAVEL
TAYLOR & WOLTMANN
CIVIL & SANITARY ENGINEERS
COVELL ROAD

Layout of the Sewage Treatment Plant of the Bloomington and Normal Sanitary District, Illinois

the way, is about 15 feet above the level of the sludge beds.

The plans for the pumping stations bear the name of Associates of J. L. Pillsbury, a firm of architects in Bloomington, continuing the notable work of the deceased founder of the firm. Stanley Pinel, who was employed by Taylor and Woltman on the preparation of the plans became later the resident engineer on construction and since putting the plant in operation has been superintending it to determine how closely it approaches to the efficiency for which it was designed. A visit during the summer showed satisfactory action and the test under the more difficult conditions of the winter season is now under way. J. L. Simmons Company of Bloomington are the contractors, who have recently finished the cleaning up and adjustment of the plant under Mr. Pinel's direction.

Sewage Collection System.—The area of the Bloomington and Normal Sanitary District is about 8.5 miles, comprising practically all of the two cities. There are about 80 miles of sewers, carrying from 6 inches to 96 inches diameter. These sewers discharged into Sugar Creek in its passage through the two cities, through nine outlets. An intercepting sewer 2 miles long was built to take the ordinary flow of sewage and the first storm water washings from the streets. It taps all the outlets, the upper end taking the sewage from Normal in a 27-in. pipe, which increases in size as the various outlets are reached until it becomes a 51-in. vitrified segmental block sewer, which enters the disposal plant from the north. A dam was built across the invert of each of the combined sewers, high enough to turn the sewage and the proper proportion of storm water into the intercepting sewer, all flow in excess overflowing into Sugar Creek. It is believed that the dilution of sewage by storm water, thus provided for, will be sufficient to prevent any nuisance in Sugar Creek. If not, change in height of dam in sewer can be made to insure greater dilution as the amount of sewage carried by such sewer may increase in the future.

The new plant is designed for a population of 54,000 people, fully twice the population now actually connected with the system, and by proper operation can handle considerable overload, including such as may come when the storm flow is at its peak. There is plenty of room, and the plans provide for doubling the capacity of the plant as constructed, by duplicating the settling tanks, sludge beds and sprinkling filters, on favorable ground adjoining the present respective structures. Space has been provided in the buildings for the necessary additions to pumping capacity.

Location of Treatment Plant.—As is so often necessary, the plant is located on a low flat alongside which the main drainage outlet of the cities runs, Sugar Creek, and through which a small stream runs draining a small area occupied in part by a thinly settled section of the city and in part by garden areas. The channel of this small stream has been improved with concrete bottom and walls for about 500 ft. to the point of entrance into it of the outlet from the secondary settling tank, and the bypass of the unpurified sewage in case of necessity. For about 250 ft. in the higher ground within the plant the creek is covered, the shortness of this covered section showing economy in design. Above this the channel is open up to the east boundary of the city property. The low ground within the property is protected by levees from overflow by storm-swelled Sugar Creek until it can be filled by the odorless sludge or acceptable refuse and waste dirt from outside excavations. The extension of the plant shown in the plans, will ultimately reduce the suggested filling to a reasonably small amount.

The 30-in. cast iron main, through which the sewage from the grit chambers is pumped up to the primary settling tanks, crosses above the covered channel of the small stream and is the only instance of the crossing of main lines of flow, in the design. There are, of course, some crossings by water pipes and drain tile.

The soil on the lower portions of the site is 4 to 10 ft. of black loam underlaid bywater bearing materials, mixtures in varying proportions of brown-black soil, yellow clay, sand and gravel, some of the 35-foot drill holes showing blue or other firm clay. The primary settling tanks are set on sloping bank with difference of elevations of about 7 feet, putting the bottom of the excavation for the tanks not far under the water level and some 4 ft. higher than the bottom of the secondary settling tank and the pump-house. The other structures are on or near the surface of the ground. The small area of the pump-house required excavation 18 ft. below the surface of the ground, the maximum of any structure in the plant. The advantage of delivery of the sewage to the pumps at a level up to 10 ft. above the pump center. The location of the structure is such as to have reduced the cost of excavation close to a minimum.

Motor driven centrifugal pumps of 4, 4, and 6 million gallons per day capacity have been installed and there is room for another when future demands require it. The 51-in. inlet from the grit chambers enters the pump well near its top and the outlet pumping main leaves the station at about the same elevation. All drainage in and about the house enters a 36-in. sump in the corner of the pump room under the stairway and is removed therefrom by an automatic electric bilge pump.

Flow of Sewage Through Plant.—The 30 in. pumping main raises the sewage about 25 ft. and delivers it at one corner of the battery and six primary settling tanks, each 28 ft. 4 in. wide and 90 ft. long and 29 ft. 6 in. to bottom of hoppers. The sewage may be turned to flow in a channel along one end of the tanks or along the side of the end tank and then along the other end of the tanks, thus giving ready reversal of flow through the tanks. The width of this channel decreases as each inlet to a tank is passed, from 3 ft. at the entrance to 18 in. at the farther end. Sewage is let into each flow through chamber by a 12 in. pipe leaving the bottom of the inlet channel and discharging at a depth of about 4 ft. below the water surface, depending on the position of the adjustable outlet weirs of the tanks. Each inlet pipe is controlled by a circular sluice gate over its end, operated from stand on walk-way above.

Between these inlet channels and the tanks are located the outlet channels into which the settled sewage flows over adjustable weirs 6 ft. long. These outlet channels increase in size in the direction that the inlet channels decrease from a width of 2 ft. to one of 4 ft. The inlet and outlet channels together occupy a bracket on the outside wall of the tanks, which is 7 ft. 10 in. wide overall.

Between the double walls of each alternate pair of tanks is a space partly filled with sand on which rests a concrete channel into which flows the sludge brought up from the tank hoppers by cast iron pipes and from which by pipes and channels it reaches the sludge drying beds and is distributed over them. The valves opening the sludge pipes are operated by hand wheels on the sidewalk above. This sludge channel should be very easy to clean after each drawing of sludge.

Among other items deserving special mention as convenient accessories to the plant are the full supply of water under pressure from the water supply pump house shown on the sketch, and the elevated tank so that every part of the plant can be kept clean and can be washed out thoroughly in case of stoppage by anything but ice. This winter will be a better criticism of the ability of the sewage to resist the fall of the thermometer than any which can be written at this time.

Glass Roof Over Sludge Drying Beds.—The greenhouse roof over the first six of the 20 sludge drying beds, and the possibility of supplying additional heat to that of the sewage and the sun, if necessary, will take care of a situation which might give considerable trouble without these provisions if the best action of the settling basins requires drawing of sludge at any time during the winter. Unless the weather is too erratic, it should be possible to make drafts of sludge from the tanks at times when the weather conditions are favorable to rapid drying of the sludge under glass cover, and not otherwise. A provision of grooves in the walls of the gas-chambers of the settling tanks has

been made so that if desired covers can be put on which will slope to a central tube leading the escaping gases to storage tanks (not yet provided for) to use as fuel for any desired purpose. There will be plenty of use for heat about the plant, for the best results in this case as well as for other purposes. Proper treatment promises so far to prevent the formation of odorous gases about the plant or to decompose them before letting them go, in case their conservation for use as fuel is not decided upon.

The dosing tanks are automatic, four in number, alternating in pairs, each pair serving one of the two sets of sprinkling filter beds. The 30 in. delivery pipes through the gallery between the filter beds reduce in size as each branch to a sprinkler lead is passed until they reach 16 in. diameter at the farther end. The branches through the beds are each of 8 inches diameter with standard ⅞ in. orifice sewage nozzles 14 ft. apart, the first being 11 ft. from the central gallery and the last being a half-nozzle, 4 ft. from outer gallery and just before the 8 in. pipe reduces to a 4 in. connection with outlet and with wash-water pipe.

The collection channels on the bottom of the filters are in the concrete base, trapezoidal in section, 3 in. deep by 9 in. in top width. They are covered by bricks, 1½ by 4 by 13 in., set on edge and alternating so as to leave 1½ by 13 in. spaces through which the water percolating through the stone reaches the channels.

The Specifications.—The brevity of the engineering specifications deserves attention. The specifications for materials occupy 7 pages of ordinary textbook size, printed in the large, 11-point type common to such books. They 22 items or paragraphs, liberally spaced on the pages. Sewer pipe and blocks, concrete materials in detail, steel for various uses, cast iron, lumber, expansion joints, valves and special appurtenances are all covered. The specifications for construction are equally brief and comprehensive. Excavation, backfilling, laying sewer, block or pipe, water pipe, concrete, placing valves, gates, etc., in full detail occupy not quite 19 similar pages, covering work done at unit prices. Such items as grit chamber, the engineering portion of the pumping station, primary settling tanks, sludge drying beds, dosing tanks, sprinkling filters, secondary tank, sludge-pumping station and appurtenances, paid for in lump sums, are fully covered in 22 pages and 4 additional pages cover some special work, some paid for in lump sums and some by unit prices. In addition are the usual General Conditions, and papers pertinent to advertising, bidding, signing the contract and bonds. Inspection indicates that results equal to those obtained under far more extended specifications have been obtained.

The Albany, N. Y., Typhoid Fever Damage Suits

The Appellate Division of the Supreme Court of New York State has unanimously the action of a supreme court jury which in November, 1926, awarded $2,000 to a minor and $1,000 to his father on the claim that the patient contracted typhoid fever from the drinking water of the city.

In April, 1924, Mr. Charles R. Cox, Assistant Sanitarian, Division of Sanitation, State Department of Health, Albany, N. Y., comments in the case as follows in the November Journal of the American Water Works Association.

The water supply of the city of Albany is secured from the Hudson River at a point about 8,000 ft. north of the main portion of the city. An elaborate water purification plant is utilized to treat the heavily polluted Hudson River water. This plant consists of aerators, coagulation basins, rapid sand filters, secondary aerators, slow sand filters and chlorination equipment. The chlorinated water from the clear well flows to a high pressure pumping station about 8,000 ft. south of the filtration plant through a conduit.

The filtration plant is under expert supervision and water of a safe sanitary quality has been discharged into the clear well. The conduit conducting the effluent from this clear well to the high pressure pumping station, however, consists of about 8,000 ft. of steel piping 48 in. in diameter, most of which is covered with concrete. The steel conduit had been in use for over 20 years and the walls had become seriously corroded at points. This conduit is laid for the most part under the bed of the abandoned Erie Canal, which normally contains about 1 ft. of water due to local drainage. In April, 1924, a flood of the Mohawk and Hudson Rivers occurred and the abandoned Erie Canal was flooded to a depth of from 6 to 8 ft. with polluted Mohawk River water.

During April, 1924, there was a sudden increase in the prevalence of typhoid fever in the city of Albany, and during this period the tap water in the city contained increasing numbers of colon bacilli, as determined by bacteriological examination in the State Laboratory.

Suit was brought against the city of Albany by the parent of one of the patients who contracted typhoid fever at this time. A decision in favor of the plaintiff was handed down by the Supreme Court in 1926, which decision was appealed to the Appellate Division of the Supreme Court in May, 1928. The important portions of the opinion of the presiding justice of the Appellate Division are quoted below:

> It is claimed that the disease had its inception in unwholesome water furnished by the city, and this condition arose through the negligence of those in charge of the water system in failing to purify the water delivered to consumers; and that the authorities neglected to give warning, although they had notice that dangers existed. . . .
>
> Beginning on April 7, the water was tested at the state laboratory by and under the supervision of Dr. Wachter, a chemist in the Division of Laboratories and Research of the State Department of Health. These tests were made from the tap which was on the same system as that furnishing water to plaintiff's family. On nearly every day between the 7th and the 23d of April, colon bacilli were found in increasing numbers, indicating some definite source of pollution not eliminated by the filtration. About this time there was a sudden increase in gastro-intestinal diseases in the city. The officials in charge of the water department had notice of the defective condition of the conduit, the sudden pollution of the water, and of the outbreak of diseases traceable to impure water, but the warnings were ignored. It was a time for prompt and decisive action. There were two possible sources of contamination—one by impure water passing the filters into the well; the other by introduction of polluted water into the conduit. The exercise of vigilance would have led to discovery of the dangerous condition, and reasonable diligence would have provided the remedy. It was possible by greater chlorination before the water went into the clear water well, to eliminate all dangerous bacilli which had passed the filter; and there was a chlorination plant at the Quackenbush St. pumping station which would have removed the new pollution occurring in the conduit, but this was not put in use, at least during the first ten days in April. Common prudence would have suggested a notice to citizens that the water had become polluted, and a recommendation that all water intended for human consumption should be boiled. But no preventive measures were taken until an epidemic had broken out. . . .
>
> To insist that the plaintiff must establish that the infection came from the city water by positive proof, would be to require an impossibility. It is sufficient if it is shown by the best evidence available that the bacilli were introduced into his system by means of the city water, so that the jury may by reasonable inference reach a conclusion to that eeffct. This is not speculation, but a process of logical deduction. . . .
>
> The plaintiff gave proof excluding other sources of infection. The defendant's counsel in argument merely suggests that there are other possible sources, but there was no sufficient proof on its part of their presence or of the probability that such causes intervened to furnish the origin of the plaintiff's disease. The epidemic at this particular time, including such a large number of cases, would under the circumstances shown, indicate a common origin. . . .

Particular attention is called to the next to the last paragraph above, since it is not unusual in cases of this kind for attorneys for the defense to attempt to make the plaintiff furnish positive proof that the infection came from the water, which, as the court justly says, is an impossibility.

Since this outbreak of typhoid fever, great care has been exercised in maintaining 0.20 to 0.25 p.p.m. residual chlorine in the tap water in the city about ¾-mile from the point of application, although this practice has naturally resulted in the delivery of water with a chlorine taste at frequent intervals. The city authorities have installed a booster pumping station at the filtration plant, which places the repaired conduit under a positive pressure at all times, so that any appreciable leakage would be of filtered water outward rather than polluted surface water inward. The water passing through the conduit is again chlorinated at the high pressure pumping station.

The steel conduit is being replaced by cast iron pipe at considerable expense. This pipe line will be used until the new water supply from the Catskill Mountains is completed, which will permit the abandonment of the Hudson River supply, and the use of the cast iron pipe as a main feeder for the northern portion of the city of Albany.

The Function of Aeration in Water Purification

A Paper at 10th Texas Water Works Short School

By N. T. VEACH
Consulting Engineer, Kansas City, Mo.

AERATION has been employed in water works practice since its inception, as is evidenced by the cascades and fountains, commonly found in water systems, both ancient and modern. There is no evidence, however, that the fountains or cascades used previous to the early eighties were installed for any reason other than that of beauty, although it is possible that reduction of odors may have been noticed in some cases.

The use of aeration as an adjunct to water purification in this country dates back to 1883, when its use was investigated by Leeds in connection with water purification studies at Philadelphia, and, since that time, aeration in its many aspects has been studied by numerous investigators. Many technical articles on aeration have been published since 1900, and a study of this subject leaves no doubt of the fact that, while aeration is established as an important aid in water purification, it is not, in any sense, a "cure-all," or a complete treatment for water troubles, and unless used properly, may be an actual detriment to the water.

What Simple Aerators Will Do.—The investigations on aeration have proved beyond a doubt that, with simple aerators:

1. Oxygen may be added to water to the point of saturation.

2. Carbon dioxide may be largely, but not completely, removed.

3. Odors and tastes, when due to gaseous products of organic decomposition, may be removed to some extent, but when due to products of organic decomposition in solution, the effect is negligible.

4. Odors and tastes due to coal tar, phenol, oil refinery and similar wastes, are affected little.

5. Odors and tastes due to overchlorination may be satisfactorily removed.

6. Odors due to hydrogen sulphide are easily eliminated.

7. The actual oxidation of organic matter in solution or suspension is negligible, but some inorganic compounds, notably those of iron and manganese, are largely, but not completely, oxidized.

8. The "aggressiveness" or corrosiveness of some waters, usually "soft" or "peaty" waters, is increased by addition of oxygen, but that of surface water commonly encountered in the Middle West, is not appreciably affected.

9. The economy and effectiveness of treatment with the ordinary coagulants is, with few exceptions, increased.

10. The bacterial content of the water is often reduced appreciably.

When Aeration Should Be Considered.—From the foregoing conclusions it is evident that the water works man must consider aeration when designing or operating a water plant, to treat:

1. Waters which contain iron or manganese held in solution by carbon dioxide.

2. Waters which contain carbon dioxide and which are to be softened, or which, due to their carbon dioxide content, are "aggressive."

3. Waters from algae-laden reservoirs or reservoirs upon which ice forms.

4. Some rivers which are hard to treat with ordinary coagulants, or which, during low water, approach the conditions found in an impounding reservoir.

Several questions which must be answered for each individual case and which, unfortunately, can be answered only in a general way, with plenty of allowance for numerous exceptions, are:

1. How complete is the aeration required?

2. Is aeration economical, in view of the fact that carbon dioxide can be removed by the use of approximately 15 lb. of lime (or an equivalent amount of soda ash), per million gallons of water per part per million of CO_2?

3. At what stage in the treatment-process should the water be aerated?

4. Which of the numerous types of aerators should be used?

Usually, if aeration is needed at all, it should be carried through to an extent which will saturate a water which is originally devoid of oxygen. If carbon-dioxide removal is the object, this extent of aeration will ordinarily leave not more than 5 parts per million in solution when highly-charged waters are treated, and will remove, approximately, 50 per cent when the original amount of carbon dioxide is from 5 to 10 parts per million. Further aeration will, of course, effect a more complete removal, but at a rate so slow that it is out of the question from an economic standpoint.

If removal of odors is the object, this extent of aeration will permit a thorough "sweeping out" of the gases which cause the trouble, and, to obtain further removal of odors, actual oxidation of the organic matter which causes them must ordinarily take place. This will require a period of aeration much longer than that obtainable in the usual type of aerator, and, in addition, the aeration to be effective must take place in the presence of certain "oxidizing" or nitrifying organisms. This is the underlying principle of the "activated-sludge" process of sewage disposal.

The results obtainable by various types of aerators will be discussed below, but, for ordinary waters, an additional head of 8 ft. will be sufficient to provide this amount of aeration.

The economy of aeration can be determined by balancing the cost of the additional head required against the cost of additional lime or soda-ash treatment. If softening or coagulation is to be practiced, as is usually the case, this additional cost of chemicals is all that need be considered.

At Albuquerque, N. Mex., the city water, obtained from wells, has approximately 6 parts per million of carbon dioxide in solution. An iron-removal plant with facilities for feeding lime is to be built. The cost of pumping the water against an additional head of 8 ft. amounts to 83 ct. per million gallons, while the additional cost of lime necessary to remove the 3 parts per million of carbon dioxide which an aerator can be expected to remove is only 45 ct. per million gallons. Generally speaking, an aerator cannot be economically justified for waters which contain less than 10 parts per million of carbon dioxide unless the elimination of odors enters into the problem, in which case aeration is, of course, necessary.

Aerators have been used successfully before and after sedimentation, and, in several recent installations, the effluent from sand filters has been aerated before storage. Ordinary purification-plant design, however, usually precludes aeration at more than one location, and, for the customary water encountered in the central part of the country, the practice of aerating the raw water before further treatment is well established and seemingly satisfactory.

At Moberly, Mo., water is aerated immediately after the addition of chemicals, with rather poor results, due to

the fact that the partially formed floc is broken up by the action of the aerator. Pirnie reports a case in Danville, Va., where a reduction in chemical dose was made possible by aeration for removal of CO_2 immediately after the addition of alum.

The selection of the proper type aerator for use is, of course, a matter to be determined for each case, to fit the local conditions, of head, quality of water and treatment-process.

The aeration devices commonly used in water purification may be divided into general classses as follows:

1. Air-lift pumps.
2. Injection aerators in which air is blown into the water.
3. Gravity aerators in which the water flows out of riser pipes, flows in thin sheets over weirs, cascades, or inclined planes, drips through perforated pans, or percolates through beds of suitable ballast.
4. Fountains, where the water is sprayed into the air through nozzles.

Air-Lift.—Air-lift apparatus for water pumping from deep wells has been in use for years and is well known, but its aerating effect on water has not been given much consideration until fairly recently.

Donaldson, at Memphis, found that air-lift pumping reduced the carbon dioxide in the local well water from 107 to 30 parts per million.

Air-lift equipment coupled with simple riser-pipe inlets to storage basins, at Pittsburg, Kan., has been effective in removing hydrogen suphide odors.

Injection Aerators.—Aerators of the injection type have been used for water in a few instances, but, at the present time, this practice is largely limited to aeration of sewage, with the purpose of continuous aeration at a relatively high rate in the presence of nitrifying organisms, and for a period long enough for actual oxidation of organic matter to take place. This requires from four to six hours, while the ordinary aerator as used in water practice, operates for a period of only one or two seconds.

At Hackensack, N. J., a substantial reduction has been effected by air blown through the stagnant layers of a reservoir by means of a gridiron system of small pipes, and at Essex, Ont., air applied at the rate of 5 cu. ft. per 100 gal. through a single filter plate 12 in. square, increased the dissolved oxygen from 2.0 to 4.5 cc. per liter, reduced the carbon dioxide from 6.6 to 3.9 parts per million and completely removed, approximately, 10 parts per million of hydrogen sulphide. Aeration, in this case, was primarily for the purpose of reducing the necessary rate of chlorine feed, which, due to absorption by hydrogen sulphide, was 40 parts per million in the unaerated water, to 3 parts per million in the aerated water. Aeration, in this instance, effected a net saving of 50 lb. of chlorine per day and presents a rather novel and interesting use for this treatment.

The principal objection to this form of aeration is, of course, the fact that the air blown through the water precludes the use of valuable basin-capacity for coagulation or settling, and the cost of providing additional tanks for this purpose is, usually, out of the question from a standpoint of economy. However, where head is not available, or in cold climates, this type of aerator may be used to advantage.

Gravity Aerators.—Probably most of the aerators now in use are of the gravity type, which general type, as stated above, includes riffle-boards, riser-pipes, cascades, spilling-weirs, coke-beds, etc.

This is probably due, partially, to the relatively low head required and partially due to the fact that, for given capacities, gravity aerators can be constructed at a cost lower than that of other types.

Inclined planes studded with riffle-plates are used at Cambridge, Mass.; Plattsmouth, Nebr.; Norristown, Pa., and several other plants.

At Cambridge, 14 million gallons per day of filter-effluent is treated on riffle-boards which cover 923 sq. ft. and which are set in a slope of 3 ft., horizontal, to 8 ft. vertical.

From 20 to 30 per cent of carbon dioxide is removed by this process, which represents a loading of, approximately, 10 gal. per square foot per minute.

At Portsmouth, Va., four steps each 13 in. high are used, and about 40 per cent of CO_2 is removed.

In tests made at Memphis on the aeration afforded by allowing water to flow evenly over an inclined walkway 10 ft. wide, 28 ft. long, with a drop of 2 ft. in length, 46 per cent of carbon dioxide was removed from water which originally contained 28 parts per million.

At Excelsior Springs, Mo., an aerator of the multiple-pan type has been in use for 12 years. Water enters this aerator through a riser-pipe, which terminates in a steel pan 7 ft. wide, 20 ft. long and 4 in. deep. From the sides of this pan the water spills successively into two pans 4 ft. wide, thence into four pans 2 ft. wide and thence into 8 pans each 1 ft. wide. The four tiers of pans are set 1 ft. 9 in. apart, vertically, and the total drop from the upper pan to the floor of the collector is 7 ft. 6 in. The total area of the pans is 620 sq. ft. and the total weir length is 600 lin. ft. When operated at a rate of 512 gal. per minute, approximately 68 per cent of the CO_2 was removed from water with an original content of 85 parts per million.

Multiple-pan aerators of this type are in successful use at Topeka, Kan.; Lawrence, Kan., and a number of other places, and recently, at the suggestion of the Kansas Board of Health, flat slabs of lumber or concrete have been used in place of the pans, at a considerable saving in cost, and no decrease in efficiency.

An aerator of the multiple-pan type, but with perforations in the pan bottom, was constructed at Superior, Wis., in 1901, and gave excellent results, as did one of a similar plan built at Winchester, Ky., about the same time. Most of the early aerators used as an aid to water purification were installed for the purpose of iron removal and a common expedient was to allow the water to percolate through beds of coke coal or other ballast.

Carbon dioxide is removed to some extent by this process, since the water flows in thin films over the ballast and the oxides of iron on the ballast itself acts as a catalyzer in the oxidation of the iron. This process is still in use in many plants, but generally, in connection with pre-aerators, settling basins and filters, and experience has shown that, for complete removal of iron and manganese, lime or soda-ash treatment must be included in the process.

Fountain Aerators.—Aerators which employ jets or sprays seem to be more generally used now than heretofore, probably due largely to the development in recent years of nozzles, which will operate efficiently at low heads. Satisfactory results are obtained at Charleston, S. C., with a head of 4.5 ft., and at Sacramento, Calif., a "floating" type of nozzle which will operate at still lower heads has been developed. Ordinary nozzles require heads of from 15 ft. upward.

Another reason, and a potent one, for the selection of the fountain-type of aerators, is the opportunity offered for "dressing up" the plant. As Mahlie very truthfully says in his article on "Aeration in Water Purification," "a ½-in. pipe spraying water in the air over a pool, apparently satisfies the general public more than a 6-in. line discharging sterilized filtered water beneath the surface."

Where head is available for fair-sized water streams, extremely sightly arrangement of nozzles can be made, as evidenced by recent installations at Denver, Colo.; Oakland, Calif., and elsewhere.

Exclusive of the question of head, spray nozzles offer the most efficient method of aeration, and experience indicates that the nozzles which throw a whirling, fine spray are the most efficient.

Donaldson's experiments at Memphis provide an excellent yardstick for determining the amount of aeration obtainable by different types of aerators.

He found that water which contained 28 parts per million of carbon dioxide, lost, approximately, 14 parts per million, or 50 per cent, on being discharged from a 2-in. riser-pipe and falling 5 ft., and that this rate was fairly constant while the flow varied from 40 to 110 gal. per minute. When an 18-in. cir-

cular splash table was placed 18 in. below the top of the riser-pipe 18 ppm. was removed at a discharge of 95 gal. per minute and 12 ppm. was removed when the discharge was 40 gal. per minute. When a pan 18 in. square, perforated with 211 holes, was placed 5 ft. above the receiving basin, a removal of from 14 to 17 parts per million of CO_2 was effected. Three 12-in. coke beds set with 12-in. openings between them, and a total vertical fall of 6 ft., effected a reduction of 21 parts per million at a loading of 70 gal. per square foot per minute, and of 24 parts per million when the loading was reduced to 10 gal. per square foot per minute.

Spray-nozzle experiments on the same water showed that it is possible to reduce the residual carbon dioxide to two or three parts per million with discharges of from 80 to 100 gal. per minute, and that they were more efficient than aerators of the gravity type.

It is interesting to note that in the case of Memphis, aerators of the gravity type and consisting of multiple pans of coke, were selected for construction, even though a greater efficiency was shown by the sprays.

Summary.—Results of tests on aerators of different types, operating under different heads on different waters, vary so greatly that no general conclusion can be made as to the effect any particular type of aerator will have on a given water, and one is forced to the conclusion that, for safety, design should be based on actual tests made under operating conditions on the water to be treated.

The efficiency of aeration in iron and manganese removal, odor removal, treatment for aggressiveness or corrosiveness, and as an aid to coagulation, is established, and like filtration or carbonation, aeration is a valuable tool, to be used in the proper place in the water-treatment plant.

Methods of Financing Extensions in Large Cities

A report compiled by the Municipal Reference Division of the Seattle Public Library for the Water Department of Seattle, Wash., shows that three methods of financing water main extensions were in use in the 33 cities of over 200,000 population in this country. The following extract from the report gives the information on these methods:

Assessment.—The costs of extensions are assessed against abutting property, in whole or in part, in the following cities:

Cincinnati. $1.50 to $2.50 per front foot according to pavement. This is estimated as one-half actual cost. Property on undedicated streets must pay all costs.

Cleveland. $2 per front foot, maximum charge. Corner lot assessed on one side only.

Columbus. Cost of 8-in. main or less with deductions for frontage supplied with water within 30 days (1924 information).

Detroit. 75 ct. per front foot. Corner lot assessed on one side only.

Los Angeles. District assessment bonds, or 80 ct. per front foot. If property is in excess of 200 ft. a deposit of 80 ct. per front foot on each side of street beyond 200 ft. is required. Deposit returned when new services are installed for other property fronting the mains, or at end of 5 years.

Milwaukee. Cost of 6-in. main. One-third of total frontage of corner lots exempt when main is laid on long side.

Minneapolis. One-half cost of 6-in. main. Corner lot assessed for long side; short side exempt up to 66 ft.

Omaha. Cost of 6-in. main. Two-thirds of side of corner lot exempt.

Philadelphia. $2 per front foot. One-third of one side of corner lot exempt, not to exceed 50 ft.

St. Paul. $1 per front foot payable in 10 yearly installments without interest. Short side of corner lot assessed up to 125 ft.

Seattle. Cost of not more than 8-in. main in residence district. Maximum charge $2.25 per front foot. Corner lots assessed for side on which building faces. Business districts assessed for cost of main necessary. Corner lots assessed on both sides.

Washington. $2 per front foot. 100 ft. exemption on corner lot.

Water Funds.—Cost of extensions are paid from the water funds in the following cities: Boston, Buffalo, Denver, Jersey City, Indianapolis (private company), Kansas City, Mo., New York, Oakland (private company), St. Louis and Toledo. (Information is of 1924 for Boston, Buffalo, Denver, Jersey City and Toledo.)

In the following cities costs are met from water funds with certain exceptions or provisions:

Akron. Assessment basis is used only in allotments where allotment company assumes and distributes the entire cost.

Baltimore. A deposit of $1.50 per linear foot is required but this is refunded to the extent of $100 per lot if a house is built within 10 years. Property owners must pay any extra costs due to street not being within 6 in. of established grade.

Chicago. An assessment on the cost of a 6-in., 8-in. or 12-in. main is made, but 90 per cent of the assessment is returned when a survey shows a revenue of 10 ct. per linear foot. This is generally within 5 years.

Louisville. If revenue does not justify the extension, property is assessed but a refund is made if revenue is sufficient within 5 years.

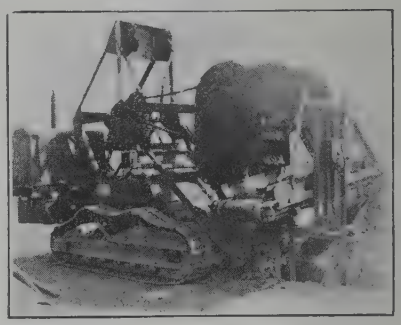
Portland. Six per cent revenue must be guaranteed.

Providence. Seven per cent revenue must be guaranteed for unaccepted streets (1924 information).

Ditching Machine Economical with Limited Trenching Program

The use of a light ditcher is often real ecomony for the community having as little as 12,000 lin. ft. of ditching to do in the course of the year. An interesting case has been recently reported that bears out this assertion.

During 1927, the City of Kalamazoo, Mich., operating a Barber-Greene vertical boom ditcher, dug 12,128 lin. ft. trench for 6 in., 8 in., and 24 in. water mains, reported the following cost data,



Light Ditcher Used in Kalamazoo, Cost Data on Which Are Given on This Page

as compared with costs of similar work by other methods done during the previous year:

	Per lin. ft., 6 in.	Per lin. ft., 8 in.
1926	$1.64	$2.73
1927	1.47	2.14

The actual costs of operating the machine for that year, showing the total and per lineal foot costs as given out by Earle E. Norman, Department of Public Utilities, were found to be as follows:

	Cost for 12,128 lin ft.	Cost per lin. ft.
Gasoline	$ 48.18	$0.00398
Oil	7.19	.000594
Grease	9.14	.000754
Repairs	119.49	.00994
Repairs, labor	64.38	.00538
Total operating cost	$ 248.38	$0.02065
Depreciation	831.64	.068
Total	$1,080.02	$0.08865

To these costs must be added moving costs of $5.28 per mile and a rental charge of 10 ct. per lin. ft. for the use of the machine, which charges were made in this instance.

While comparative costs are not available on the 24 in. main, the department has stated that while the estimate on a project for laying 24 in. main using other methods was $12,500, that the job was actually done in 1927 with this type of ditcher for a labor cost of $9,065.73 and a machine cost of $342.28, giving a total cost without material of $9,408.01, thus making a total saving of just over $3,000. At least $2,000 of this saving, it was stated, could be directly ascribed to the use of the machine.

Design Data For Open Gravity Type Rapid Sand Filters

Elementary Features Described at Texas Water Works School

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The writer will restrict his paper to design data pertaining only to the filter unit itself and more specifically to the open gravity type of rapid sand filter.

The original rapid sand filter unit was built circular in form, constructed out of wood or steel. Nowadays it is customary to construct such filters out of concrete and to build them rectangular in form. Some of the advantages gained by this are durability, elimination of waste space and the use of the concrete walls of the filters as a support for the building covering them. The rectangular shaped filter has many other advantages, chief among which is the fact that a more efficient underdrain and wash water distributing system can be adapted to it.

Filter Capacity.—For average conditions the capacity of a filter to be used for domestic supply is based upon a rate of flow of 2 gal. per minute for every square foot of sand bed area. In other words, if a certain filter is to have an output of 300 g.p.m., the area of the sand bed should be 150 sq. ft. If the filter is to be used for clarifying water, without regard to the removal of bacteria, its rate may be increased to three and sometimes as high as 4 gal. per minute per square foot of sand area. If, on the other hand, the filter must be designed to purify a highly contaminated water, or if the filter is to be used in connection with an existing mixing chamber, and settling basin yielding low efficiency, it would be advisable to increase the sand bed area so that the filter could be operated at a slower rate than the standard rate of 2 gal. per square foot of sand surface per minute.

After knowing the total capacity of filtered water in gallons per minute required to meet a particular case, it is only necessary to divide this sum by the rate at which the filters are to be operated in order to determine the total filter sand bed area. For example, if the plant is to have normal capacity of 700 g.p.m., and is to be operated at a rate of 2 gal. per square foot of filter sand surface per minute, the total sand area would be 350 ft.

Number of Filter Units.—The next step is to decide the number of filter units that the toal capacity is to be divided into. This is determined by size of plant, possibility for future extension, ground space available, economy in first cost, operating expenses, etc. Unless the filters are designed for an ample reserve capacity above the maximum requirement, it is advisable to build them in comparatively small units, so that when one or more are out of service for washing or repairs, the remainder may still be able to meet filtered water demand. On the other hand, if there are indications that the consumption of filtered water may rapidly increase after installation of the filter plant, it would be more economical to use larger filter units and have their total capacity considerably in excess of present requirements.

There is no fixed rule for determining the correct proportion between length and width of a filter unit. This depends upon capacity of filter, type of underdrain system to be used and other factors. As a general rule, the length of a filter should be from 10 per cent to 30 per cent greater than its width. This shortens the length of pipe gallery and operating floor, thereby reducing cost of pipe and the distance that the operator has to cover in order to manipulate the filter valves and devices. Moreover, wash water troughs and strainer systems can usually be better adapted to the long and narrow unit than to the short and wide filter or the absolutely square unit. For example, a filter unit having a capacity of 500,000 gal. per 24 hours is very frequently required, and unless adverse conditions obtain such a unit is usually built 15 ft. long by 12 ft. wide. As a result, patterns for the underdrain systems and wash water troughs have been made by all equipment manufacturers for this standard size. If the same sand area, namely, 180 sq. ft., were made up by designing a filter 20 ft. long by 9 ft. wide, it would make it difficult to arrange strainer system and wash trough for uniform distribution and would crowd the valves, valve stands, controller and other appurtenances.

Depth of Filter.—Most engineers require a total depth of sand and gravel of about 4 ft. In order to prevent the carrying away of the filter sand, the top of the wash troughs are placed about 2 ft. above the top of the filtering material or approximately 6 ft. above the bottom of the filter. As the level of the water on top of the filter varies to some extent in most plants, space should be provided above the wash troughs to take care of this variation. Usually about 2 ft. is allowed for this so that the average filter has a total inside depth of about 8 ft. This depth may be increased or diminished within certain limits if necessary, but these limits are determined by local conditions as well as economy of operation. For example, the vertical distance between the water level on the filter and the outlet of the filter which constitutes the head under which it is being operated should be about ten or twelve feet in order to get the maximum output between washings of the filter.

If local conditions make it impossible to carry the filter effluent pipe some distance below the bottom of the filter, the filter would be built deeper than the customary 8 ft. and still give a total operating head within the limits just mentioned. On the other hand, if conditions make it necessary, the depth of the filter could be reduced by cutting down the depth of filter material, lowering the top of the wash troughs and not allowing as much space above the wash troughs for variation of water level. In any event, however, it is very poor practice, except where absolutely necessary, to reduce the inside depth of the filter more than a few inches or at most a foot below the generally accepted minimum depth of 8 ft.

Underdrain System.—The underdrain system of a filter was originally designed to accomplish three purposes, first, collect the filtered water from under the gravel bed; second, distribute the wash water; third, prevent the passage of sand from the filter. Nowadays, most practical filter engineers realize that a properly graded gravel bed can be relied upon even more than the strainer system to accomplish these results.

Although there have been many types of strainer systems developed in recent years, the fact remains that the older form of strainer system constructed of perforated pipe laterals and modified to meet any particular requirements is still more popular than any of the newer types. This, as above stated, is principally due to the fact that improvements in the design of the gravel bed have robbed the strainer system of some of the principal functions. As far as we see it, the merits of one form of underdrain system over another should be determined chiefly by minimum friction loss, during ability, economy in first cost and maintenance, easy access for cleaning or repairing.

Layer No.	Passing a Screen Having Circular Openings of the Following Diameter	Retained on Screen Having Circular Openings of Following Diameter	Depth of Gravel Layers
1 (on bottom)	2½ in.	1½ in.	4 in.
2	1½ in.	1 in.	4 in.
3	1 in.	½ in.	4 in.
4	½ in.	¼ in.	3 in.
5 (on top)	¼ in.	1/12 in.	3 in.
Total depth			18 in.

Thickness of Gravel Bed.—From what has just been said, it follows that the gravel bed placed over the underdrain system is a most important element in the filter. By using a layer of coarse gravel immediately over the strainer system and placing upon this layer successive layers of smaller sized gravel tapering the bed from coarse at the bottom to fine at the top and by making the total depth of gravel between 18 in. and 24 in., it is possible to prevent the loss of sand and at the same time obtain uniform collection of filtered water and a correct distribution of wash water.

Sanitary engineers working independently of each other have gradually developed specifications for gravel bed that are very similar. In one of our largest filter installations of recent date, the specifications call for the following gravel sizes and depth of each layer, and these same specifications with slight modifications are almost generally used nowadays.

The Sand Bed.—The quality of the water to be filtered determines to some extent the size of sand grains and depth of sand bed that would be most effective. The largest sand grains that will obtain satisfactory filtration are apparently the best to use as they offer less resistance to the flow of water during either the filtering or washing process. For all practical purposes, a filter sand having an effective size of between 0.40 and 0.50 mm. with a uniformity coefficient not in excess of 1.7 is suitable, provided, of course, that it has a high specific gravity and contains a minimum amount of perishable substances, such as lime, etc.

The depth of sand bed most commonly used is 30 in., although some designers, realizing that only the first few inches of sand on the surface of the bed do practically all of the filtration, have reduced this depth to in some cases 27 in. and even below.

Assuming that provisions have been made to satisfactorily coagulate and settle the water before applying it to the filter, there seems to be no real foundation for specifications calling for sand much finer than 0.40 mm., as small sand grains increase loss of head through the filter, necessitating more frequent washing without apparently increasing the efficiency of filtration. Naturally the more uniform the sand grains run in size the less likelihood there will be of unequally distributing it during the washing process.

There is still some difference in opinion as to whether rounded sand grains are preferable to sharp grains, but as far as we know, no conclusive evidence has been presented to solve the problem definitely one way or the other. In any event, if sharp grains of sand are used, they will in time become more or less rounded by the washing process.

Wash Water Provisions.—Wash water troughs are designed of sufficient size to discharge the wash water freely without filling up under maximum wash water rate of flow. The top edges of each trough should be absolutely level and the top edges of all troughs in the filter should be in the same horizontal plane with each other. The troughs must be placed at just the proper height above the sand bed. If too high, much of the heavy sediment will fail to pass into the troughs, and after the washing process will settle back on top of the sand. If too low, sand will be carried over into the troughs.

As a general rule, the top edges of the wash troughs should be about 2 ft. higher than the surface of the sand bed, although naturally this distance is controlled by the rate of wash water that is to be used. The troughs must be placed close enough to each other so that the horizontal travel of the water will not be too great. If the troughs are too far apart, much of the dirt which is carried with the water will settle out before it reaches the troughs. If the troughs are too close to each other, there is a likelihood of carrying sand into them. A common practice is to place the troughs parallel to each other and about three and a half feet apart.

Effluent Rate Controller.—In order for a filter to maintain a uniformly high efficiency, it is necessary that the rate of flow through it be kept within the limits of its capacity. It is furthermore imperative that no sudden change in the rate of flow should occur, as this might cause a serious disturbance in the sand bed. To obtain these results, an effluent rate controller is placed in each filter outlet pipe. The merits of one type of controller over another are determined by many considerations, some of which are as follows: Its ability to maintain with a minimum of error any rate for which it has been set, irrespective of the changes that take place in pressure within the filter. Facility for regulation of the controller for any desired rate without undue loss of time or trouble. Its gradual responses to such changes in rate without sudden shocks. Simplicity of design and minimum loss of head required for its operation. Durability, economy of maintenance and repair and accessibility to moving parts.

While the filter is in operation the impurities removed from the water gradually accumulate and build up a resistance to the passage of water through the filter to such an extent that finally the filter will fail to yield its normal output. Most efficient results are obtained if the filter is washed just before the drop in output occurs. Naturally, if the filter is washed before this time, there is a needless waste of washwater. If filter is allowed to operate under decreased capacity, it not only interferes with the requirements for filtered water, but there is also a possibility of compacting the sand bed to an extent that would require excessive washing with consequent disturbance of the filter materials. It is therefore necessary to provide a device known as a loss of head gauge, which indicates to the filter operator the proper time for washing the filter.

Methods of Control.—The operating values of a filter may be controlled manually, hydraulically or electrically. Electrically operated valves fulfill all of the requirements of the hydraulic valves insofar as ease of operation and labor saving are concerned.

If first cost would be entirely disregarded, there would be no reason for using hand operated valves as they entail loss of time and extra effort. Besides, the valve stands used to manipulate them are of necessity so placed as to waste space and detract from the appearance of the plant. When the valves are hydraulically operated, they are controlled by an attractive looking table made out of marble or other material and concentrate the efforts of the filter operator and make it less possible for him to manipulate the incorrect valve. In a large filter plant it is imperative to use hydraulically operated filter valves first because the valves are large and would be unwieldly to manipulate by hand, second, because they save labor and effort. Some of the smaller plants do not absolutely require the use of hydraulically operated valves, and on account of their greater first cost depend upon manual control. As stated above, however, it would be preferable to have valves hydraulically operated even in small filter plants, but limited funds frequently prohibit this.

There are many other useful devices used in connection with a rapid sand filter, such as gauges for indicating or recording the rate of flow of water through the filter, appliances for obtaining samples of water from different sources in the filter plant, wash water rate controller for maintaining a uniform rate of wash water to the filter, etc. These, however, have to do more with the operation of an entire filtration plant and as the scope of this

paper is limited to design data pertaining only to the filter unit itself, we shall not attempt to go beyond this limitation.

In order to be brief, the writer has in some instances made bare statements without attempting to prove them, and has by no means covered all the important points of design of a rapid sand filter, but only what he considereed the elementary features.

Tracing Underground Waters

How Uranine Dye Was Used to Locate Outlet of Creek

By A. W. CROUCH
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IN connection with some recent work at the Great Falls Plant, located near Rock Island, Tennessee, it was necessary to locate the outlet of a small sinking creek lying some eight miles north-east of the plant. After a study of the whole situation and some ineffective tests with potassium permanganate several tests were made using uranine dye. This dye was found very effective in tracing underground water.

General Conditions.—Sinking Creek emerges from the ground at the foot of a low mountain ridge about two miles north of the town of Doyle. It flows on the surface of ground in a south-easterly direction for about ¾ mile and sinks in an irregular row of small holes along the foot of a limestone bluff.

The rock formation in this section of the country consists of Bangor limestone with a dip to the East of 30 ft. or less to the mile. The beds of rock vary in thickness from a few inches to many feet with numerous clay seams and clay pockets scattered throughout the area. Caves, underground streams, sink holes and springs are very common over the entire section. The Calfkiller River, flowing south, is about three miles east of the sink hole in which the dye was placed while the Caney Fork River, flowing west, is about five miles south of the sink hole. There are many springs of various sizes along the banks of both rivers.

A rather definite line of sink holes and caves extends from the point where Sinking Creek disappears to a point on Calfkiller River known as Hensley's Spring. By air course it is 2½ miles away. Taking this fact into consideration together with the fact that the rock dips to the east it seemed probable that the Hensley Spring was the outlet for Sinking Creek although later developments proved that this was not the case.

What Uranine Dye Is.—Uranine dye is a coal tar product, being one of the numerous compounds derived from resorcin. The latter is made by fusing gum resins with caustic potash. Uranine is a reddish brown powder, which when dissolved in water, turns the water green. It is particularly adapted for coloring large volumes of water as it is easy to handle, readily soluble, safe and can be detected when present in very small quantities. From some rough test made in the laboratory it was easily seen when present one part in five million. It can be detected when present one part in ten million. When present in small quantities it is most easily seen by placing some of the water with the dye in it in a test tube and holding it so that the light strikes the side of the tube.

All the tests were made during the month of October, 1927. The stream flow in Sinking Creek at the point where it sinks was 1.4 cu. ft. per second at the time of the tests. No appreciable amount of rain had fallen for several weeks. As stated above it was expected that the outlet would be found along the Calfkiller River and it seemed reasonable to suppose that it would not take over one or two days to get results.

How the Tests Were Made.—One and one-half pounds of dye was dissolved in water in large tubs and dumped into the creek at the sink holes in the first test. At the end of the second day no trace of the dye had been found at any of the springs along either river. Another pound of dye was then poured directly into the sink holes without first dissolving it in water.

On the morning of the fifth day after the first batch had been put in Sinking Creek green water was found at the Johnson Spring, on Calfkiller River, located three and one-half miles south-east of the point where Sinking Creek disappears. The stream flow at this spring was 2.7 cu. ft. per second. By night-fall all trace of the Uranine had passed. Two days later or five days after the second batch of dye had been put in the creek green water was again noticed at the Johnson Spring. As in the first case all the colored water had passed by dark. Judging by the strength of the color in the early morning it is probable that the Uranine was first present at the Johnson Spring some time during the night preceding. This spring is 71 ft. below the level at which Sinking Creek disappears.

A third test was made two weeks after the first two under similar weather and stream flow conditions. In this test a glass jar was placed in the middle of the stream 15 ft. above the sink holes. At the start of the test one ounce of Uranine was dissolved in water and poured directly into the creek. A continuous stream of water containing the dye was then discharged into the stream from the glass jar through a glass siphon at the rate of one ounce per hour dissolved in 2 or 3 gal. of water. Every half hour an extra heavy dose was poured in the creek. After continuing in this way for 4½ hours another ounce of Uranine was poured directly into the creek. A total of eight ounces of Uranine were used in this test. The dye was well mixed with the creek water before it sank to insure a more uniform distribution of the color. It was thought that all the small sink holes might not discharge into the same channel underground.

Colored Water Appears.—On the morning of the fifth day after the dye had been put in Sinking Creek green water appeared at the Johnson Spring on Calfkiller River. The color was the brightest on the afternoon of that day and could be seen up until late in the afternoon of the following day. Colored water was also found in a well at Onward 4½ miles south-south-west of the sink holes. This well is fed by an underground stream, the bed of which is about 6 ft. lower than the place where the Uranine was introduced. On the sixth day the water from Reno spring, five miles South of the sink holes and on the banks of Caney Fork River, was green up until about 11 o'clock. This spring had a discharge of about 1 cu. ft. per second and is 87 ft. lower than the sink holes where the dye was introduced. It has been reported but never verified that green water was also seen at a small spring one mile West of Reno.

Preliminary investigations indicated that the outlet of Sinking Creek would be found along the Calfkiller River. The outlet at Johnson's spring was in line with this reasoning. The outlet at Reno was a surprise. It is evident that a study of the rock formation and general topography of the country will prove helpful in locating the probable direction that an underground stream will take but such a study should not be relied on entirely. Close watch should be maintained at all springs in the neighborhood.

Measurements of the stream flow should be made at both the point where the stream sinks and at possible outlets in order that proper quantities of Uranine can be put in the water. Allowances should be made for the many uncertainties that are sure to be encountered.

Conclusions Regarding Use of Dye.—It appears to be advantageous to put the Uranine in the stream to be traced in small quantities over a long period rather than to dump the whole batch of dye in at one time. The advantage lies not merely in the fact that the color is retained in the water longer but that it gives the observer time to get from one spring to another throughout the territory before the effect of the dye has passed.

Acknowledgment.—The foregoing is taken from a paper presented by the author at the Third Annual Meeting of the Kentucky-Tennessee Section of the American Water Works Association, held at Louisville, Ky.

Automatic Traffic Control Signals for Boston

PLANS and specifications have been completed by John F. Hurley, Traffic Engineer, Traffic Engineering Division of Boston, Mass., for the first unit of automatic traffic signals for the downtown section of the city.

The accompanying plan shows the area to be controlled under present plans. This is known as Unit No. 1. This plan provides for automatic lights on Washington St., from Broadway to Haymarket Sq.; on Tremont St., from Broadway through Scollay Sq., Bowdoin Sq. and Cambridge St. to Temple and Staniford Sts.; on Boylston St., from Arlington St., through Park Sq. to Tremont St.; on Park St.; on Beacon St., from Park St. to Tremont St.; on Summer St., from Arch St. to Washington St.; and provides for the regulation of traffic flow on the connecting streets between Washington St. and Tremont St., from Broadway to Court St.

A comprehensive automatic control system for the entire downtown district, northeast of and including Massachusetts Ave. is the ultimate plan. Unit No. 1 is the first link in this chain of signals and is so designed that future installations may be added and may be operated through the same cables without overloading them.

Central Control.—The traffic flow will be regulated by a central control device located at City Hall. This central timing device will be designed to accommodate all future interconnected installations in the downtown area.

Progressive control signals will be installed, so called, because they are timed to permit a continuous movement of traffic at a predetermined speed. For example, this scheduled timing, it is expected, will make it possible for any driver once in step with the traffic signals on Washington street, to move northerly through Washington St., Adams Sq. and Haymarket Sq. under normal traffic conditions, with no steps at intersections, provided a speed of approximately 15 miles per hour is maintained. Both the speeder and the laggard will be penalized at the next control intersection if, in any block, he exceeds or falls below the set schedule. This detailed timing plan gives each cross street an adequate opportunity to move its vehicular traffic and especially provides for more frequent opportunities for pedestrian crossing. Under the recommended timing the maximum wait of a pedestrian for a clear opportunity to cross Washington St. will be 40 seconds, which is a material reduction of present practice.

15 Mile Speed.—By actual test runs made, the average vehicular speed on Washington St., between Broadway and Haymarket Sq., is less than seven miles per hour. Under the proposed timing method an average speed of 15 miles an hour can be obtained.

While the speed has been fixed at approximately 15 miles an hour in the downtown area, this speed may be varied from the central control station as conditions will require. It is customary to reduce the speed during morning and evening rush hours and during periods of rain, snow or slippery conditions.

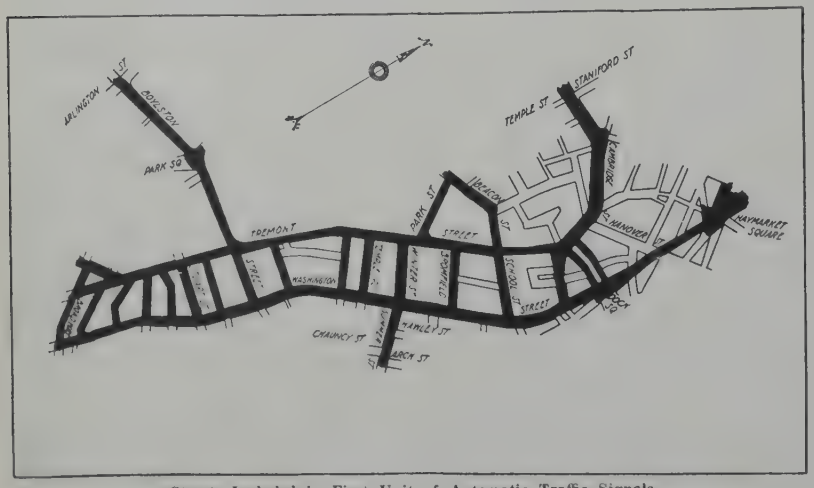
Traffic Light Mounting.—All traffic lights will be mounted on posts on the far right corner where practical. Where a far side mounting cannot give adequate visibility, an alternate or auxiliary signal will be mounted at or near the point where vehicles are required to stop.

The control system is so designed that the lights at any one intersection may be turned off at that intersection, during an emergency, without affecting the operation of the balance of the system. When shut off in this manner the mechanism continues in operation so that when the lights are again turned on they will be in step with the rest of the system. The entire circuit can be shut down at the central control station.

Present plans call for delivery of the equipment in April. It is expected by that time most of the cable construction work will be completed so that installation of the lights may start immediately after delivery. Most of this installation work must be done at night to avoid traffic congestion. Approximately three months will be required for the completion of the installation.

While the installation of Unit No. 1 is in progress, plans will be in progress for Unit No. 2, along Massachusetts Ave.; Unit No. 3, along Summer St., Washington St. North and Cambridge St. extension; Unit No. 4, along Commonwealth Ave. and approximately 25 isolated intersections in the outlying districts.

A traffic engineering division has been established to carry on this work and to conduct scientific engineering studies relating to traffic movement, congestion and accidents throughout the city. Dr. Miller McClintock of the Erskine Bureau for Street Traffic Research has been retained as consultant to work with this new division.



Streets Included in First Unit of Automatic Traffic Signals

New Type of Airport Floodlight

At the International Aeronautical Exposition and Conference at Chicago and Washington the General Electric Company introduced a new type of airport floodlight. The new airport floodlight, designed by C. A. B. Halvorson, designing engineer of the lighting department at Lynn, Mass., contains 14 high-power incandescent lamps, giving a total of approximately three million beam candlepower. The lamps are arranged in a row in front of six cylindrical mirrors that spread the light over the field without permitting it to rise high enough to interfere with the vision of pilots landing directly into the beam of the powerful floodlight. At a distance of a mile from the floodlight there is stated to be sufficient illumination so that a newspaper can be read; and at 2,500 ft., the average maximum airport distance, the illumination is said to be sufficient so that landing pilots can quickly and accurately determine the nature of the landing surface. The plane-parabolic mirrors give the light a spread of 160 degrees horizontally and only three degrees vertically; but, since the reflectors can be adjusted, it is an easy matter to keep all of the light below the line of vision of pilots. Among the advantages claimed for the new design are that a uniform distribution of light is obtained, and a higher intensity of illumination per kilowatt of input is secured.

Importance of Proper Accounting Systems for Municipal Water Works

Important Phases in Accounting That Should Be Considered

By THOMAS S. DURHAM
Division of Accounts, Washington Suburban Sanitary District, Hyattsville, Md.

There is no problem in municipal operations more important than the adoption of a thorough system of accounts through which a full and comprehensive report of the municipality's financial condition may be determined at any time. Everybody knows and will readily acknowledge that it is impossible to guess at the cost of any operation and use this guess as a basis for accurate accounting records. A record that is not true is practically no record at all. Why do we have to keep records? I shall answer that by asking why you keep an account of your personal bankroll? You keep it because it measures your progress and clearly defines your limitations.

In connection with the foregoing I wish to ask three pertinent questions.

1. Do you keep your accounting records so that at any time you can ascertain the true cost of your water system?

2. Have you absolute proof that the municipal organization, for which you are directly responsible, is managed economically?

3. Do your cost accounting records reflect the proper credit to which your administration may be entitled?

I shall not ask you to answer these questions nor shall I go into a detailed description of an accounting system, as the time allotted will not permit, but shall try to illustrate briefly some of the important phases that are necessary to become familiar with, in order to operate and judge results in water works accounting systems.

Need for Uniform Classification.—In the first place a mere recording of transactions, without looking towards an ultimate purpose, cannot give adequate information for financial guidance. In the second place maximum results cannot be obtained unless similar information is kept by a number of allied concerns. If a uniform classification of accounts were adopted by all municipalities in this state, and the combined result studied, each municipality would receive information that could be used to materially reduce nearly all phases of operating cost. We have to know how to use these data after they are compiled. We shall take, therefore, the most important of financial statements, the balance sheet, and see what it is and why we use it.

The balance sheet of a business is like a photograph of a construction project. The photograph well tell you the exact condition of the job at the particular moment it is taken. A succession of balance sheets is a series of photographs showing your financial progress. It shows your assets and liabilities classified in such a way that it is easy to jurge the condition of your business. A glance at the debts that are due or nearly due might reveal that there will not be enough cash in the treasury to pay them. This will be your clue to get busy and immediately provide for more cash before the embarrassing situation actually confronts you. This comparison also indicates the solvency ratio.

Comparative Balance Sheet.—The comparison of each asset or liability, showing the net increase or decrease for the current period, is readily made. This affords information concerning the degree of progress. This is made particularly easy where the comparative balance sheet is used, because the totals at the beginning of the current period are listed alongside of the totals for the current period. In this way the net increase or decrease in each item is shown. The difference between the depreciation reserves and fixed assets will show the present worth of these assets. Deduct from this the fixed indebtedness and you have the present worth of your entire system. By comparing the fixed assets with the fixed liabilities the stability ratio is obtained. In fact, any number of ratios showing both financial and operating results can be made. The possibilities of use to which the balance sheet may be put are too many to discuss exhaustively but remember that the person who does not study his balance sheet is like the person who does not count his money.

Handling Bond Issues.—Each municipality has to depend largely upon its borrowing power to raise any sizeable amount of money. The most general method of doing this is by bond issue. The type of bond issued frequently for water system construction is the sinking fund bond, but there are cases where serial or other types of bonds are used. Regardless of whether the sinking fund or another type of bond is issued there is one point that needs to be stressed particularly. This is the extreme importance of formulating some definite plan for paying the interest on and retiring the bonds at maturity. We will try to see what happens when this is not done. The town of X issued bonds to install water supply and sewerage systems, no definite provision being made to set aside certain sums of money periodically to be applied to the liquidation of these obligations. The assessment may have been high enough to have amply taken care of this need, but the income was used for plant expansion and other expenses seeming more necessary at the time. The time is at hand when the bonds must be redeemed. There is only one step to be taken and that is to re-finance by another bond issue.

It is immediately known that the town of X is in financial difficulties. The market value of its bonds drops and instead of receiving a premium the town has to accept a large discount, which adds another heavy item to the debt. The town might even experience great difficulty in finding a market for its bonds. You can plainly see that it is an unwise step to allow bonds to become due without having provided for their retirement. At best there is confusion and embarrassment for each person that is in any way responsible for such a condition. Refinancing always tends to bring financial soundness into question and affects greatly the possibility of future expansion.

The foregoing is not imaginary as it has actually happened a number of times in this state. The Washington Suburban Sanitary District took over the water system of one town that would have faced re-financing in a comparatively short period but had made absolutely no provision to care for the situation.

Taking Care of Depreciation.—We are all interested in depreciation because it vitally concerns every utility. We have to know something about it to make rates, levy assessments and fix valuations. I dare say that no other subject in public utilities has been more discussed and still is so vague. It is absolutely necessary to provide in some way to take care of depreciation. Otherwise, at the end of the service life of any material asset we would be left with only an empty bag to hold. I am not prepared to say whether cognizance should be taken of actual or theoretical depreciation, but it would seem from observation that the theoretical straight line method will very nearly serve in the ordinary case. Even in this method there are certain factors to be borne in mind, such as inadequacy, obsolescence, growths in water mains, electrolysis

and molecular changes, that will cause a revision of rates.

In the accounting for depreciable assets a plant ledger should be used. The plant ledger is a subsidiary record showing in detail the assets that are carried in one account in the general ledger. In this way all related assets can be kept together with a complete history of each item. This makes possible the knowledge concerning the individual service life of each asset and provides maximum ease in figuring depreciation or the adjustment of rates. Depreciation should be considered in any financial report and the proper reserves shown. The actual taking of a reserve provides a security against the lessening of invested capital. It has to be built up from operating funds as any other cost of the plant would be taken care of. The presence of depreciation reserves indicates conservative and sound managerial policies.

Cost Accounting Not Complicated.—Many people get the impression that cost accounting has some very mysterious qualities, but I assure you that it is not true. It is nothing more than the method of searching out and recording all costs that go to produce a unit of any product. The same principles must be applied to cost accounting as are used in general accounting. The purpose of cost accounting is to render easy comparison of unit costs and make it possible to exercise greater efficiency and economy in extending and operating your system. For example, suppose the expense of installing 6-in. water lines was $2.30 per foot year after year in a certain city. No attempt has been made to find what it costs other agencies to install similar work. Later, there comes to your attention the costs of several cities or companies and, upon comparison, you are astonished to find that the average cost for laying 6-in. water pipe is only $2.13 per foot. You would surely make a decided effort to locate this difference in expenditure. The above test can be applied to each and every operation that is essential in the water system, but to do this there must be uniform cost keeping among municipalities.

In modern commercial concerns the officials find that it is less costly to profit by the mistakes of others than to learn through their own experiences. For this particular purpose they have issued cost accounting statistics through which they obtain cost ratios and percentages that enable them easily to detect and remedy any items of expense that are too high or too low. They find that through comparison with like businesses they may learn their own comparative expense and are thus enabled to set about making changes necessary to increase their profits. The municipal water department or water company can be run on the same general plan.

Value of Uniform Records.—Through uniform cost accounting records we are enabled to tabulate the costs of each size of main laid during any period. These can again be divided according to foremen, which affords information that will allow the elimination of non-producers. This may bear an important relationship to future lower costs, which, in itself, may more than doubly compensate for the expense of obtaining the information.

If you are to be certain that your schedule of charges for water consumption is adequate, you must know the exact expense of producing a unit of salable water. This can be accomplished only by having a definite procedure for your guidance. If you fail to do this, there are items that will be forgotten, items of which you have no immediate record, items that you may leave for proration until some other time. The form you use should tie up definitely with your general accounting records. This will leave nothing for you to forget. You can then say definitely, for instance, that it costs 17¾ ct. per thousand gallons for your gross pumpage and 21 ct. per thousand gallons for water actually paid for by the consumer.

It is necessary to know not only the total cost but the exact cost of each operation that goes to make the completed unit. Following this procedure we discover items of excessive expense and can set about to remedy them.

In municipal utilities the users and taxpayers are the stockholders. They cannot directly share in the profits but a minimum outlay of money by them for a particular utility means a saving, and consequently a profit, to them. It devolves upon you, therefore, as administrative officials, to show the stockholder that his public utility expenses are low as compared with his outlay for other necessities. In this way the municipality as a whole will know that the profits are clearly shown and that you have played your part well.

Acknowledgment.—The foregoing is a paper presented at the Second Annual Conference of the Maryland Water and Sewerage Association.

Cost of Sewage Maintenance at Baltimore, Md.

In our issue of November 1928 there was published on page 255 a table showing data from several cities on sewerage maintenance. In compiling this table the writer obtained his information from various city officials, and noted in his paper that it was possible that some corrections should be made, realizing that some error may creep in.

In the case of Baltimore it is found that this condition exists and that the annual cost of maintenance for the sewers only should be $291,300.00 rather than the amount published. This difference will make the cost per mile $338.70, the cost per million gallons $13.28, and the cost per assessed valuation $0.015 per $100.00.

Millions Voted for Airports

By the popular voting of millions of dollars for airport construction, airports have been established as public utilities.

Nearly $8,500,000 was voted for airports at the November 6 elections. Eleven cities or counties passed bond issue propositions ranging in amount from the $5,000,000 voted by Detroit to the $25,000 approved by the people of Albany, Oregon.

In a few localities the bond issue proposition for airports was defeated but in most such instances the failure was due to circumstances which had nothing to do with the public attitude toward aviation. In Chicago, for example, where every bond issue presented by the present administration in the last two elections have been defeated, the item of $450,000 for development of the airport received the highest vote of all among the defeated projects.

During the last year appropriations or bond issues have been passed which involve more than twenty-one millions of dollars, all of which is to be spent in supplying cities and counties with needed airport facilities.

"The airport," said Captain L. D. Seymour, Assistant General Manager, National Air Transport Co., "has become a public Utility. Communities have come to realize that the benefits of the airport are general. Every aspect of a town's life is affected by the provision of an airport. At Columbus, O., organized labor worked as hard for the passage of the airport bond issue as any group of capitalists. Increased possibilities for all classes of labor were foreseen in the construction and operation of the airport and, more particularly, in the industries which will inevitably follow the establishment of the airport.

"The status of the airport as a public utility has been definitely established. The Supreme Court of Missouri has so ruled, in passing judgment on the validity of airport bonds voted by St. Louis and Kansas City."

In the preliminary designs for the majority of the proposed airports many improvements are included which would have seemed visionary to aviators of pre-war days. Administration buildings are proposed which equal modern railway terminal buildings in size and usefulness. Lighting equipment, air weather bureaus, permanent, fire-safe hangars and paved runways are but a few of the features which have become commonplace in the design of airports; none of these was to be found on any American port ten years ago.

Outer Park System for St. Louis Recommended.—An outer park system which would give St. Louis, Mo., recreation spots in scenic parts of St. Louis County is urged by Fred W. Pape, Park Commissioner, in his annual report to Director of Public Welfare Salisbury.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Happy New Year

Santa Claus left us a few distributor stories, so that means a Happy New Year for us. We hope your Christmas stockings were so full of orders that your warehouses will be left quite empty until fresh supplies arrive from the manufacturers, which will mean a Happy New Year for you.

Ninteen twenty-eight is now ancient history and we all have a new Carry On spirit for 1929. We are looking forward with pleasure to a better acquaintance with the distributors in the field, and an opportunity to present their stories to our readers.

Take advantage of this department which is at your service. If you remodel or build a warehouse, open a new office, elect officers, appoint new representatives, or go on a business trip, tell Distributor News about it. We will pass the stories of your progress on to our readers. It is a source of inspiration to the field to learn of the activities throughout the country and to know of so many men all engaged in the same line of endeavor.

Pictures add to the interest of a story, so send us your cuts or photographs of facilities or officials of your company. We are glad to hear from you and will use your contributions as far as space permits. Write us often. Address all communications to The Editor, Distributor News, Gillette Publishing Company, 221 East 20th Street, Chicago.

Localized Gatherings

One Way to Help Distributors

By LOUIS McLOUTH

Advertising Manager, Sauerman Bros., Inc., Chicago

EVERY manufacturer of industrial equipment holds an annual sales convention, which gives salesmen and distributors a chance to visit the factory and hear an outline of plans for the coming year. Sauerman Bros., Inc., of Chicago, manufacturers of slackline cableway excavators, power drag scrapers and coal-storage equipment, hold an annual sales meeting, but this convention is taken to the distributors. In other words, the Sauerman plan embraces a series of small, localized gatherings, rather than one big central get-together.

It would be easier and simpler for Sauerman Bros. to follow the line of least resistance, have their distributors and the latter's salesmen come to headquarters once a year, and call it time and money well spent. Analysis of the situation, however, convinced the company's officers that the greatest possible good could be accomplished by the sectional gatherings, which would be devoted, not to a discussion of national conditions, but how to sell the company's three main lines in the specific territory covered by that distributor and his men.

Thus every fall a flying wedge starts out from the Sauerman plant in Chicago, headed for the home territory of distributors in almost every part of the country. This flying wedge is made up of D. D. Guilfoil, sales manager; the advertising manager; W. R. Elden and H. A. Roe, engineers, and the district sales manager for the section being invaded.

On November 14 and 15 this quartette held a meeting with the distributor for the Indianapolis territory. Earlier in the month, November 8 and 9, it went over the situation with the distributor at Dayton, Ohio. Other meetings have been or will be held in St. Paul, Milwaukee, Detroit, Baltimore, and New York.

The local convention plan was adopted after it had been determined from contact with distributors and general observation that conditions in almost every part of the country differ from those in any other section. One territory may be prosperous and another may be experiencing a depression; one section may be chiefly agricultural and another may be mining; demand in one territory may be chiefly for excavators, while in another it may be largely for coal-storage equipment.

This being true, Sales Manager Guilfoil decided that the logical way to approach the sales problem was to break down the country into sections, as covered by distributors, and then to join the distributor, at least once a year, in a face-to-face discussion of what could be done to increase sales in that particular territory. The distributor's salesmen, of course, come in for the local meetings and present their own individual problems.

Mr. Louis McLouth, Advertising Manager, Sauerman Bros., Inc.

This means a lot of work for the men elected to attend these district meetings from the main office. The sales manager, even if he were so inclined, could not dismiss the discussion of selling scrapers to contractors in Ohio with a few glittering generalities. The advertising manager cannot quote a few figures showing how his company covers prospects with advertising all over the country.

On the contrary, Mr. Guilfoil goes before each meeting with a sheaf of sales statistics compiled for that particular group of salesmen. I cannot content myself with totaling the country-wide circulation of advertising mediums employed, but must break that circulation down by states, so that I can and do tell distributors and their salesmen just how many sales messages are being fired every year in their own territory.

The time spent in making these territorial breakdowns is justified in more ways than one. I learn a lot when I get this slant on the advertising situation. Likewise, the distributors' salesmen are more forcibly impressed with the figures relating to their own territory than they would be with the national coverage, because the latter has only a general meaning to them. But when you start talking about advertising in their own territory, and to the men they are trying to sell, you get both an intensely interested and a highly enthusiastic audience.

The same is true of the addresses of the sales manager, the district sales manager and of the engineers. They localize their data as far as possible, so that their remarks are made with a consideration of local conditions and to men who have to meet those conditions.

It is gratifying to see the impression made on distributors and their salesmen by the advertising circulation figures. They had no idea that the number of magazines, consolidated catalogs and directories spreading our advertising message throughout their territory was so large. After looking at these figures, their conclusions seem to run something like this: "Well, we don't see much about excavators and drag lines in the newspapers, but the figures show that it is really a big business—one we can be proud of."

They leave the convention with renewed enthusiasm, as well as additional facts which they can use in their daily work.

Most of the Sauerman district meetings are held in November and December, when the demand upon the sales department is at the lowest pitch of the year. The meetings are thus held with a minimum of loss of business.

The meetings are of the blackboard and brass tack variety. They are far more intimate than would be possible under any other conditions, and because they are intimate and of a man-to-man nature, salesmen who might ordinarily feel some constraint make bold to come out and state any problem which is bothering them. The sales manager gives the answer in the same frank way, and all of those present gain from the discussion.

The meetings are held in the quarters of the distributors in some cases and in a local hotel in others. The average meeting lasts two days. While the days are devoted to business, the entertainment feature is not omitted, one of the local hotels providing facilities for a dinner and any other program which may be desired.

The Sauerman headquarters staff is constantly on the road during these two months, and the convention period is quite a strain because of this long absence and the continuous traveling. Only the conviction that more in the way of actual results is accomplished in this way than in any other would justify this arduous effort. But Sauerman Bros. have given the plan a thorough trial, and as far as they are concerned the old mass convention is a thing of the past.

Distributor Notes

The Sidney Steel Scraper Company of Sidney, Ohio, of which Mr. John Perry is president, announces the organization of the International Automotive Equipment, Inc., a new corporation for the purpose of marketing the new patented Perry Automatic Dump Truck Body. The Sidney Steel Scraper Company has contracted to manufacture bodies on order of the Sales Corporation. The new body will be shown at the Road Show with the exhibits of the Sidney Steel Scraper Co. and the Perry Company.

Arthur E. Little

Mr. Arthur E. Little, well known in the industrial advertising field passed away after a brief illness. Mr. Little was formerly advertising manager of the Thew Shovel Company at Lorain, Ohio, and was one of the speakers at the 1928 convention of the National Industrial Advertisers' Association at St. Louis.

He was a technical expert and capitalized his knowledge in the industrial advertising field. Previous to going into the advertising work he served as a draftsman with the Cleveland Frog & Crossing Company, and chief engineer of the Jahant Heating Company. He then became connected with the advertising department of the Firestone Rubber Company, and after the war served with the Paul Teas, Inc., Cleveland and the Thew Shovel Company, Lorain.

Charles Seitz

In the recent and tragic death of Mr. Charles Seitz, the United States Cast Iron Pipe & Foundry Co., of Burlington, N. J., has lost a respected and able member of their organization. Mr. Seitz's death was the result of an automobile accident which occurred on November 30th. At the time of his death he was the Resident Manager of the Addyston Shop.

Mr. W. E. Lewis, formerly Resident Manager of the Anniston Shop of this organization has been transferred to Addyston, to fill the position left vacant by Mr. Seitz.

Branch Manager Transferred from Milwaukee to New York

Mr. H. N. Felton, formerly branch manager of the Milwaukee office of the Wagner Electric Corporation, St. Louis, has moved east to take charge of the New York office. Mr. Felton is a graduate of the University of Illinois, and served two years in the Army. He entered the Chicago district of the Wagner Company as a salesman and in 1927 was made branch manager of the Milwaukee Branch, where he continued until he was transferred to New York.

In Southern Territories

THE Dealers Equipment and Implement Co., Memphis, Tenn., distributors for the McCormick-Deering Industrial tractor and the Trackson Company's lines of equipment, have found the Trackson McCormick-Deering unit an ideal crawler tractor for road building and maintenance, according to Mr. Dunbar Abston, Vice President of the Company.

Highway work is this company's most important sales field, and the Model DH Trackson unit has proved an economical, efficient solution to the equipment problem. This year, especially, the Memphis territory is occupied with extensive road work and levee construction programs and State, County, and City officials have shown tremendous interest in the Trackson McCormick-Deering combination.

The accompanying illustration shows officials of the Dealers Equipment and Implement Co., and other members of the organization grouped around the Trackson in front of their attractive show rooms. Mr. Abston is shown at the wheel of the tractor; Robert Rust, Manager, is third from the left, with his arms folded, and Irvin Kunert, Trackson Company representative, is first to the right of the machine.

Mr. Dunbar Abston, Vice-Pres. of Dealers Equipment & Implement Co. at Wheel of Tractor; Mr. Robert Rust, Manager, Third from Right, and Mr. Irvin Kunert, Trackson Co. Representative, Immediately at Left of Tractor

The Offices of MUNICIPAL NEWS AND WATER WORKS, 221 E. 20th Street, Chicago, are headquarters for information on equipment and supplies. If you want catalogs, prices or names of manufacturers, we will gladly supply same free.

Convention of Corrugated Culvert Makers Held at Massillon, Ohio

Late in the fall a meeting of the Toncan Culvert Manufacturers' Association was held at Massillon, Ohio, to formulate plans for selling and advertising activities for 1929. The members assembled in the executive offices of the Central Alloy Steel Corporation.

The utmost optimism was expressed regarding the business outlook for 1929, and practically every section of the United States and Canada was represented at the conference. A considerable expansion of the Association's trade activities was decided upon to be started at once.

Several new members, acknowledged leaders in their respective territories, joined the Association during 1928, thereby adding strength to the organization, and plans have been made for enlarging the membership still further in 1929. Officers for the ensuing year were elected, and a meeting scheduled for August.

Change of Address

The Cutler-Hammer Company of Milwaukee, Wisconsin, announces that after December 1st the address of their Atlanta, Georgia, office will be 150 Peters Street. This office will furnish sales and engineering service on Motor Control apparatus and Wiring Devices, and will also have warehouse facilities for carrying in stock many types of standard devices. This will insure to customers in that territory direct and prompt shipment. Because of the increasing electrical power application to industry in this section of the country the Cutler-Hammer Company has provided this service to anticipate the needs of its customers. Mr. A. C. Gibson is manager in charge of the Atlanta office.

The Power Plant Supply Company, sales engineers and contractors, who have been in business in Detroit since 1911 announce their removal from the Penobscot Building to the new Fisher Building. They will be established in their new quarters after the first of the year. Mr. J. E. Walsh is general manager for this firm.

After January 1st, the address of the Eastern Paving Brick Manufacturers Association, will be 1535 Real Estate Trust Building, Philadelphia, Pa. Mr. William C. Perkins is the Chief Engineer of this organization.

Distributor Notes

The Ross Power Equipment Company, dealers in new and used equipment issue a very complete catalog of their stock. It is well classified and each piece numbered, making it very easy to inquire about any particular piece of machinery. Their announcement states that they have a background of thirty years experience in the power plant and general machinery business. If interested, write to them for a copy of this catalog. They are located at 9-11-15 South Meridian Street, Indianapolis, Ind.

New England Implement Co. Adds McCormick-Deering Line

The New England Implement Company with large establishments at both Boston and Worcester, Mass., is one of the oldest Trackson distributors in the country. They have sold hundreds of Trackson units in New England for road work and snow removal purposes which are their biggest sales fields, and also for general construction work.

Their tractor and equipment business is one of the largest in the East and they recently took over the distribution of McCormick-Deering tractors and the Trackson Company's lines of Full Crawlers and other equipment adapted to use with the International power plant.

Eastern Distributors Add Line of Tractors

Because of the increasing importance of the tractor as a power plant for highway, general construction and industrial purposes, the Tractor & Equipment Company of Newark, N. J., for many years dealers in automobile bodies have added tractors to their equipment line. This company was recently appointed distributors for the Trackson Company of Milwaukee, Wis., to handle Industrial McCormick-Deering tractors and also the Trackson full-crawlers, loaders, shovels and other equipment for the International tractor.

Messrs. Lyman and Holloway of the Tractor & Equipment Co., enthusiastically report a keen display of interest in the outfits making up the Trackson-McCormick-Deering combination. A variety of fields for tractor and equipment sales is offered in the metropolitan industrial section which comprises their territory.

We present a picture of a Model DH Trackson McCormick-Deering unit with Mr. Lawrence Coons at the wheel making a test before equipment is delivered.

Warehouse and Showrooms of Tractor & Equipment Co., Distributors at Newark, N. J. Mr. Lawrence Coons, Tractor Salesman at Wheel of Model DH Unit

New Lines Wanted

Editor's Note—Distributor News receives from time to time letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment which they would like to represent. Items of this kind will be published and names and addresses furnished interested persons upon request.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

New York company interested in representing manufacturers not already established in eastern market, or considering a change in sales arrangements.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

A Michigan distributor of many years experience, representing at this time many prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturer needing increased distribution facilities in this region.

A contractor's superintendent located in Florida would like to represent some road equipment manufacturers in this territory.

A manufacturer of paving expansion joints is looking for distributors for Northern California territory.

New Appointments

The Continental Motors Corporation, through the manager of its Industrial Division, Mr. L. J. Kanitz, announces the appointment of Mr. Sid Harris as Industrial Sales Engineer in the East, a field in which Mr. Harris has a wide knowledge.

Independent Pneumatic Tool Company to Enlarge Plant

The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, manufacturers of Thor Pneumatic, Electric and Contractors Tools, will build an addition to their factory located in Aurora, Illinois.

The new structure will consist of a modern, fire-proof, concrete construction building and will add 36,000 square feet to their present capacity.

Caterpillar Acquires Russell Grader

On December 13th the Caterpillar Tractor Company announced by telegram that negotiations, which had been pending, had been concluded with the Russell Grader Manufacturing Company of Minneapolis, whereby it had acquired the business and facilities of the latter company. The plant formerly occupied by the Russell Grader Company at Minneapolis will be used by the Road Machinery Division of the Caterpillar Company where they will continue to manufacture the Russell line of road building machines. Hereafter all Caterpillar tractor dealers in this country and abroad will have charge of the sale of Caterpillar tractors, Russell road machinery and Holt combined harvesters. The latter are produced in the harvester division of the Caterpillar Company located at Stockton, California.

The Caterpillar Company, whose headquarters are in San Leandro, California, has announced its intention to build an eastern combined harvester factory at Peoria, Illinois, where its principal tractor plant is now located.

Timken Roller Bearing Co. Establishes Permanent Offices in Far West

The Pacific Coast territory of the Timken Roller Bearing Company has been reorganized, with the result that a permanent office has been established in Los Angeles, California, and one in Seattle, Washington. Mr. Roy Cross, located at 1361 South Figueroa Street, will have charge of the Los Angeles office, and Mr. Marshall Cooledge with address at 321 South Pine Street will direct the Seattle office. Mr. G. C. McMullen will continue to serve from the Company's San Francisco office as district manager.

Construction Machinery Co. Plan Road Show Dinner for Representatives

Mr. R. C. Weller, sales manager of the Construction Machinery Company, Waterloo, Iowa, announces that their annual dinner for representatives will be held at Cleveland at the time of the Road Show. The dinner will take place at the Cleveland Hotel, Monday evening, January 14th. Discussion will center around the many interesting features of the combined Construction Machinery and Marsh-Capron program for 1929, according to Mr. Weller's announcement. Indications point to many improvements to be offered in the new models which are to be shown under the Wonder or Marsh-Capron banner at the Show.

The Construction Machinery line is now one of the most complete in the field with Wonder Tilting Mixers; Marsh-Capron Drum Type Mixers; Mechanical Hoeman Plaster Mixer; Power Sawyer; Construction Machinery Company Hoists and Blackhawk Snow Plows.

New Sales Manager Appointed by Penn. Dixie Cement Co.

The appointment of Mr. Walter S. Wing as General Sales Manager for the Pennsylvania-Dixie Cement Corporation has just been announced. Mr. Wing will be in general charge of the marketing

Mr. Walter S. Wing, General Sales Manager for Pennsylvania-Dixie Cement Corp.

of the corporation's products and will be located at 131 East 46th Street, New York City.

Mr. Wing entered the steel business in Pittsburgh, during the summer of 1907, following his graduation from Cornell University with the degree of Mechanical Engineer. About a year later he was transferred to a subsidiary company, the Universal Portland Cement Company, where he remained until very recently. For the past 13 years his office has been in Pittsburgh, where he served the Universal Company as Eastern Sales Manager.

Public and civic affairs have always interested Mr. Wing and he has taken part as an active member of the United States Chamber of Commerce, Pennsylvania State Chamber of Commerce, Ohio State Chamber of Commerce, Pittsburgh Chamber of Commerce and the Civic Club of Allegheny County. He is also a member of the American Society for Testing Materials, Cornell Society of Engineers, and in Pittsburgh is a member of the Duquesne Club, University Club, Longue Vue Club, Railway Club of Pittsburgh, Automobile Club of Pittsburgh, Pittsburgh Builders Exchange and others.

Browning-Ferris Co. to Handle Tracksons

The Trackson Company, Milwaukee, Wis., manufacturers of Trackson Full-Crawlers, Loaders, Shovels, Cranes, etc., announce that they have arranged with the Browning-Ferris Machinery Co., 205 Exposition Ave., Dallas, Texas, for the distribution of Trackson equipment for McCormick-Deering Tractors.

These distributors will have the entire state of Texas for their territory. They also have branches in Houston, Fort Worth, and Amarillo. They are authorized distributors for McCormick-Deering Industrial tractors, and are in a position to give quick service on the International and Trackson lines.

Wemlinger, Inc., Opens Chicago Office

Word has just been received that Wemlinger, Inc., 149 Broadway, New York City, has opened an office in Chicago at 228 North La Salle Street. This office will be under the direction of Mr. Alexander Mayer who is thoroughly equipped to help the contractors in all matters concerning steel sheet-piling and to render many services to the customers of Wemlinger, Inc. Practical suggestions concerning the product of this company is mailed out in unique folder style each month to interested users of piling. This service is called "Piling Facts" and a line to either the Chicago or New York office, we are sure, will place your name on the mailing list to receive this information.

New Appointments

The Harnischfeger Corporation of Milwaukee, Wis., has enlisted the services of the Ed. P. Phillips Machinery Co., of Richmond, Va., as new district agents for the Virginia territory.

The Phillips Machinery Co., has satisfactorily supplied the needs of a large number of Virginia contractors, over a period of many years. They will handle the complete line of P & H Excavating equipment, including shovels, draglines, clamshells, trench-hoes, skimmer scoops, trenchers and backfillers.

Announcement has been received that McCarthy-Jones & Allen Co., Inc., 111 First Avenue, South, Nashville, Tennessee, has been appointed distributor of all the products of the Botfield Refractories Co., Philadelphia, Pa., manufacturers of Adamant Fire Brick Cement; Adamant-Adachrome Super-Refractory Mixtures and the Adamant Gun.

Murray - Wheeler Company, 329-31 Ellicott Square, Buffalo, New York has been appointed distributor for the Eastern territory for the Erie Machine Shops, Erie, Pennsylvania, manufacturers of Erie steam and gasoline rollers.

Municipal Official
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Hose Coupling Vib-Restor.—This is the trade name given to the latest addition to the pump industry by the Chicago Pump Company, 2336 Wolfram Street, Chicago. This is a vibration deterrent for horizontal centrifugal pumps presented by the engineering department of this company. It is a scientifically designed rubber hose coupling, special rubber fabric and special couplings being employed in the manufacture. This coupling is recommended by this company where a quiet pump installation is desired. If interested write to Mr. Clem Peterson, at the above address for folder on Vib-Restor. If you will mention this magazine it will be appreciated.

Water Softeners.—The International Filter Company, 333 West 25th Place, Chicago, present in an illustrated bulletin Crystalite, a water softening product. This is an attractive 16 page booklet, well printed on heavy enamel paper. It discusses the chemistry of zeolite water softening; the early history and development of zeolites; Crystalite as a super rapid zeolite; the advantages of upflow softening illustrated with curves. Crystalite Water Softeners installed by the International Filter Company are illustrated, and special industrial uses for Crystalite are listed. If writing for this bulletin, kindly mention our magazine.

Distribution Transformers.—Bulletin 160, recently issued by the Wagner Electric Corporation of St. Louis, Missouri, is a 52-page catalog describing Wagner distribution transformers in a single-phase and three-phase, pole type and subway-type, in ratings up to and including 500 Kv-a. Detailed description of design and construction of these distribution transformers fills the first half of the catalog, while the remainder is given over to ratings, shipping weights, prices, etc. Mr. C. B. Dietrich, identified with the St. Louis office of this company at 4600 Plymouth Avenue, will be pleased to send you a copy of this book on request. If you will mention this magazine it will be appreciated.

Chlorination.—Wallace & Tiernan, Newark, New Jersey, manufacturers of chlorine control apparatus will be pleased to send you full particulars in regard to the sterilization of water by their method, and to furnish you with record of cities where their apparatus is being used. If writing for information, we would like to have you mention our magazine.

Dual Control Trencher.—Bulletin 20-X gives detailed information regarding the P & H Trencher manufactured by the Harnischfeger Corporation, 3902 National Avenue, Milwaukee, Wis. One of the important features of this equipment is the fact that the operator can work from either side. This company has branches in all the principal cities. Write to Mr. H. S. Strouse for copy of this bulletin, mentioning this publication.

Dragline.—Write to Koehring Company at Milwaukee, Wis., or to any of their branches in the principal cities, for Dragline Bulletin DL9. The ease of control and speed in functioning are important features of this heavy duty Koehring equipment. Mr. O. C. Dahlman will furnish bulletin on request. If writing mention our magazine.

Centrifugal Pumps.—Write to De-Laval Steam Turbine Company, Trenton, N. J., for Catalog B-64, which gives detailed information concerning the reliability and economy of these pumps, which are widely used by American municipalities for automatic pumping stations. In writing to Mr. H. B. Watson of this company for the bulletin, kindly mention our publication.

Francois Cementation Process.—The Dravo Contracting Co. have acquired the sole American rights to the Francois patents, and have a highly skilled staff who will be pleased to help you with your problems. This method of grouting covers chemical processes for a hundred and one different cases, the engineers of the Dravo Company are ready to help you solve your problems. Write to their company at Pittsburgh, Pa., mentioning our magazine.

Sewer Cleaning Machine.—W. H. Stewart, whose factory is at Walkerville, Ontario, has branches in St. Louis, Mo., Jacksonville, Fla., and Boston, Mass., so that his patrons on this side of the border may be served without paying duty. Literature describing his sewer and conduit rods will be furnished on request. Rods will be shipped on trial. If writing to Mr. Stewart for information concerning his equipment kindly mention our publication.

Manhole and Catch Basin Covers.—Write to Wm. E. Dee Company, 30 North La Salle, Chicago, Ill., for particulars concerning the different types of manhole and catch basin covers. Prices will be included on request. If writing, kindly use the name of our magazine. This company also manufactures sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick.

Cast Iron Pipe.—The U. S. Cast Iron Pipe and Foundry Company of Burlington, N. J., have branches in all the principal cities and will be pleased to send you full information if you will state your requirements. They manufacture pipes for all purposes. If writing for information, will you mention our publication.

Hydrants, Valves, etc.—Full particulars for supplies needed by water works and fire departments will be sent upon request by the Bourbon Copper & Brass Works Co., 618 E. Front St., Cincinnati, Ohio, manufacturers of fire hydrants, gate valves, and extension valve boxes. Write for their catalog, giving the name of our magazine.

Trencher.—Details and specifications of the new Parsons Model-31, the big full-crawler trencher, manufactured by the Parsons Company, Newton, Iowa, may be secured upon request. Before offering this machine to the market it was given a thorough test by its sponsors and they would like to tell you all about it. Like its predecessor, the Parsons 21, the 31 is built to dig at either side or in the center and digs with boom offset so that it can handle close-quarters jobs where some machines might fail.

Valves.—Golden-Anderson Valve Specialty Company located in the Fulton Building, Pittsburgh, have issued a descriptive and data catalog on their automatic valves for steam and water service. Full details are given on each page as to construction, operation variations together with cross-section drawings. Data required for ordering is made very clear. If you desire a copy of this catalog write to Mr. J. A. Voland of the Golden-Anderson Company mentioning the name of our magazine.

Meter Testers.—A catalog giving complete information on the Mueller Meter Tester will be sent upon request if you will write to Mr. C. N. Wagenseller of Decatur, Illinois, mentioning this publication, or they may be secured at any of the branch offices of this company. The Mueller Meter Testers are simple of operation and of a lasting quality of construction. Statistics show that meters under-register oftener than they over-register and an accurate meter tester insures honestly earned revenues. Meters should be tested befor installation and at regular periods

thereafter. The Mueller catalog will give you complete information on this subject.

Zeolite.—"Softening Municipal Water Supplies by the Use of Zeolite" is the title of a bulletin issued by the Zeolite Chemical Company, 140 Cedar Street, New York City. This booklet describes Green Sand, a natural base exchange Zeolite Mineral, used for the purpose stated. Write to Mr. R. E. Wagner of the Zeolite Company for a copy of this bulletin. If writing, we would appreciate it if you would mention this magazine.

Meters.—The Union Water Meter Company of Worcester, Mass., with offices in New York City and Philadelphia, will be pleased to send you literature concerning their King Frost Protected Meter, built to overcome every known weakness in frost meter design. If interested in meters of this type write to Mr. E. K. Otis for full particulars. We would appreciate it if you would mention this publication.

Hydrants and Valves.—The Mathews Fire Hydrants, built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia. If you will write to Mr. C. Becker of this company he will gladly send you full information about their sand-cast and "sand-spun" centrifugal cast iron pipe fittings, valves, boxes and hydrants. Please use the name of our magazine if writing.

Automatic Air-Lift.—The Sullivan Machinery Company, 130 South Michigan Avenue, Chicago, Ill., has a handbook on their atuomatic air lift, and special automatic control information of particular interest to water works superintendents. A letter to the Sullivan Machinery Co., attention of Mr. S. B. King, will bring you this information. Ask for Catalogs 6171-I and 6156-J. If you will mention the name of our magazine we will appreciate it.

Filtration Plants.—Officials considering filtration plants will find much interesting information in the literature of the Norwood Engineering Company, Florence, Mass. If writing mention our paper.

Cast Iron Pipe.—James B. Clow & Sons, 201-299 North Talman Avenue, Chicago, with foundries at Coshocton, Ohio, Newcomerstown, Ohio, and Birmingham, Alabama, carry large stock of pipe at points where large supplies can be obtained on short notice. Wire or write them concerning your requirements, they will be glad to care for your needs without delay. Mention our magazine when writing this company.

Lubricant.—The Dot Lubricant Equipment Company, Division of the Carr Fastener Company, Cambridge, Mass., has issued a unique little folder called "Little Journeys in Dot Lubrication," illustrating and describing the various steps in the use of this lubricant. The trip described is that of taking the grease from the storage tank to the bearings quickly, comfortably for the user, absolutely free from dust and dirt.

Centrifugal Pumps.—In order to be of assistance to users in choosing the right pump for their needs, Bulletin 1632-I has been issued by the Allis-Chalmers, Milwaukee, Wis. Types for steam turbine drive, motor drive or gasoline engine drive are described to best fit the purposes of installation. Write to Mr. H. G. Hoffman for copy of this bulletin, mentioning Municipal News and Water Works.

Sanitary Specialities.—Manufactured by the Servicised Products Corporation include Bituminous rope, sewer compound and sewer belts (both acid and root proof), and asphalt liner slabs, proof against sewer liquors. Illustrated literature giving complete descriptions and details concerning these products for obtaining permanently tight and lasting sewers will be sent upon request by the Servicised Products Corporation, 6051 West 65th Street, Chicago, Ill. If you will mention our publication when writing to Mr. A. C. Fischer of the Servicised Company for this information it would be greatly appreciated.

Moir-Buchanan Centrifugal Process.—This process is to obtain high density, low absorption and long life of concrete pipe. Rights to use this process may be secured through the Asphalto-Concrete Corporation, 1440 Broadway, New York City. If interested in learning about this process and how strength and durability are secured by this method write to Mr. Geo. H. Schroder of the Asphalto-Concrete Corporation, using the name of our magazine and ask for full particulars.

Chlorinator.—Bulletin W-21 issued by the Paradon Manufacturing Company of Arlington, N. J., describes in detail the Paradon Chlorinators for city and private water and sewage systems, industrial plants and swimming pools. If writing for this bulletin address Mr. R. V. Donnelly, care of the manufacturer. We would appreciate it if you would mention our publication.

Cast Iron Pipe.—The Central Foundry Company, manufacturers of cast iron pipe with offices located in the principal cities, will be pleased to have you call at the nearest office or write to the New York office, 420 Lexington Avenue, for complete information in regard to their product, an iron to iron joined pipe, allowing for expansion and contraction, vibration and uneven ground settlement. Used for water supply, fire protection and other service.

Valves.—The Darling Valve & Mfg. Company with offices in New York, Chicago, Houston and Oklahoma City and headquarters in Williamsport, Pa., will be pleased to send you full information in regard to the design and performance of their valves which are built to minimize friction and wear. If writing for literature to Mr. A. G. Smith at the Williamsport office of the company, kindly use the name of our magazine.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, illustrates and describes the Anderson pipe cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating, and will make a clean cut in gas or water main in the trench. All parts are of steel or malleable iron. Prices for the cutter in different sizes are given, as well as a price-list of all parts. Further information will be furnished upon request. If writing kindly mention this magazine.

Rayflectors.—The trade name of patented reflecting devices designed for utilizing light from automobile headlights, or other outside sources, to make signs and signals visible at night. The Rayflectors are manufactured by the Ray-Signs Corporation, of New Haven, Connecticut, and are described and well illustrated in a very attractive, well bound, 12-page booklet. These devices come in three sizes and in white, red, green and amber. This black and gold booklet will be sent upon request by the manufacturer, and we would appreciate it if you would mention our publication when writing.

Road Maintenance.—Several attractive pieces of literature have been received recently from Edw. J. Jockoboice, Grand Rapids, Michigan. A 12-page enamel-paper booklet describes in detail and illustrates the Monarch Road Planer and Maintainer. The sharp and carefully lettered and numbered illustrations both in this booklet and in broadsides issued by this company make it easy to comprehend the outstanding features of this machinery. The blade on the "Perfection Reversible Monarch" Road Planer is set with swinging arms attached to each side of the truck which allows the blade to be swung to reserve angle, thus whether cutting to or from the center of the road the truck is always with traffic.

Seal Tight Expansion Joints.—The necessity for expansion joints, types that have been used, types of premoulded joints, etc., are discussed in a little booklet called Seal Tight issued by W. R. Meadows, Inc., Elgin, Illinois. Allowances must be made for the expansion and contraction of concrete as affected by weather conditions, and this booklet gives results as accomplished with Seal Tight in controlling this problem. Write to Mr. W. R. Meadows at Elgin for complete information regarding these expansion joints, mentioning the name of our magazine.

Portable Compressors.—Ingersoll-Rand Company, 11 Broadway, New York City, will be glad to send you catalog describing their gasoline engine or electric driven portable compressors, in six sizes. If writing for this information, will you please mention our magazine.

Lubrication.—The story of the Alemite Manufacturing Corporation system of lubrication issued in magazine style. This pamplet, Lubrication Maintenance, is published in the interest of better industrial lubrication and lower production costs, and will be mailed free to any one interested. If writing for this booklet, will you kindly mention our publication? The address of the Alemite Manufacturing Company is 2646 North Crawford Avenue, Chicago.

Four Wheel Drive Trucks.—Several pieces of literature have just been received from the Coleman Motors Corporation, of Littleton, Colo., Washington, D. C., and Chicago. The trucks described and illustrated are Model C-25 (2 tons), Model D-40 (3 tons), and Model X-100 (5 tons). Specifications are given and the trucks are shown performing seemingly impossible feats. The front axle of the Coleman truck is placed under the frame at a point that will give an equal distribution of weight upon both axles when the truck is loaded to capacity. This factor adds to the tractive ability and to tire life. Full information regarding any or all models will be sent upon request addressed to any office of the manufacturer. If writing we will appreciate it if you will mention this publication.

Steel Sheet Piling.—Lackawana Steel Sheet Piling, particularly suitable for the long sea wall. For information regarding this product write to the Bethlehem Steel Company, Bethlehem, Pa. Mr. S. H. Yorks is sales-manager. If writing Mr. Yorks, give the name of our magazine.

Hydraulic Dredge Capacity Indicator.—The Ellicott Machine Corporation, 1111 Bush Street, Baltimore, Maryland, specialists in dredging outfits, are equipped to furnish you with well designed hydraulic dredge, either diesel, electric, gasoline or steam driven, built for efficient and economical service. Mr. C. E. Ellicott, Jr., will be pleased to furnish you full information concerning outfits for jobs of all sizes. If you will mention this magazine, he will send for your convenience a hydraulic dredge capacity indicator.

Steel.—Write to the Inland Steel Company, 38 South Dearborn Street, Chicago, Ill., for information regarding their Inland Copper Alloy Steel Sheets, made for resisting corrosion. State your requirements and particulars will be given to you on sheets, bars, plates, shapes, rails, track accessories, rivets, billets, etc. If writing for literature, kindly give the name of our publication.

Pumps, Engines, Hoists.—If you have hoisting problems, write to Mr. Clarence E. Bement, of the Novo Engine Company, 200 Porter Street, Lansing, Michigan, asking for a free copy of Novo Hoisting Handbook. This is not a catalog but a book of useful information for the man who must meet hoisting problems. They will also be glad to send you full particulars concerning their entire line of products.

Lumber.—For the users of lumber, the National Lumber Manufacturers' Association, Transportation Building, Washington, D. C., has much valuable information in booklet form, which they will be glad to send you. Bulletin No. 16 is called "Simplified Practice" and another booklet containing much general information is called "Information on Lumber and Where to Find It." Either of these booklets will be sent without obligation by addressing the company at Dept. 4651, at the address given above. If applying for a copy, kindly use the name of our magazine.

Slackline Cableway.—"Excavating for Profit" is the name of a booklet issued by Sauerman Bros., Inc., 428 S. Clinton St., Chicago, giving many instances of work done by a Sauerman machine which presented problems to the contractor to know how to handle the job at a profit instead of a loss. We would appreciate the use of our name if writing for a copy of this booklet.

Mast Hoist.—The Insley Manufacturing Company, Indianapolis, Indiana, invite your inquiries in regard to the results obtained by the use of their mast hoists. This piece of equipment handles concrete with the buckets and chutes, and also hoists miscellaneous material with a material elevator operating independent of the bucket, and with a boom handles such material as reinforcing steel which is too long for an elevator. Write for literature giving complete information on this machinery. Mention of this magazine would be appreciated.

Governors.—How to increase production and profits and lower operating costs, by the use of Pierce Governors, is described in Booklet No. 14, issued by the Pierce Governor Company, of Anderson, Indiana. This equipment on power engines results in a smooth, uniform flow of power to meet every load. Fuel, operating and repair bills are reduced and the life of engines prolonged. Mr. D. J. Nolan, of the Pierce Governor Company, will be pleased to send you a copy of this booklet, and we should be pleased if you would mention our magazine when writing.

Cranes - Shovels - Draglines. — The Koehring Company, of Milwaukee, Wisconsin, manufacturers of pavers, mixers, gasoline shovels, cranes and draglines, would be pleased to send you detailed information concerning their heavy duty construction equipment. This company emphasizes the service which goes with all sales of their equipment, and their sales offices and service warehouses are located in all the principal cities. Kindly mention the name of our publication if writing Mr. O. C. Dahlman of the Koehring Co., for literature on this equipment.

Tractors.—Caterpillar Tractor Company, San Leandro, Calif., will be pleased to send you literature on how to spread your profits by the use of their caterpillar track-type tractors and tracks so that the bull-doze blades can be run up to the very edge of dumps, spreading and filling in as fast as the earth is dumped. Write for information, mentioning this magazine.

Shovels-Draglines-Cranes-etc. — The Osgood Company of Marion, Ohio, makers of pile drivers, cranes, clamshells, shovels, draglines, back hoes, etc., will be pleased to have you write them, giving your requirements. They will furnish you with full information to meet these requirements without obligating you in any way. When writing give the name of our publication.

Electric Calculator.—For the man who has to figure, the Burroughs Electric Calculator offers lightning like help in checking stresses and strains, dimensions, areas, cubic content, estimates, payrolls, costs or other calculating. Write to the Burroughs Adding Machine Company, Detroit, Michigan, attention of Mr. H. J. Boone for further information about this electric calculator. If you will mention our magazine, it will be appreciated.

Shovels.—Gasoline, steam or electric powered shovels, cranes, draglines and backdiggers manufactured by the Thew Shovel Co., Lorain, Ohio, will be described to you in detail, with stories of what they have accomplished, if you will write for particulars to Mr. Joe Selzer, c/o The Thew Shovel Company, giving the name of this magazine.

Explosive.—For lowering blasting costs the Hercules Powder Company advise that you investigate without delay the results accomplished by the use of Hercomites. Full information concerning Hercomites No. 2 to No. 7 will be sent if you will write to Mr. N. S. Greensfelder, Hercules Powder Company, Wilmington, Delaware, mentioning this publication.

Cement.—Of interest to the cement users is the new booklet issued by The Universal Portland Cement Company, called High Early Strength Concrete. This booklet gives full details for securing strong concrete in three days with the usual materials and labor. Write to Mr. Charles S. Rye of the Chicago office of the Universal Portland Cement Company for a copy of this booklet. We would appreciate your mentioning our magazine if writing.

Electric Power.—A very attractive forty-eight page booklet, well bound and profusely illustrated, is now being distributed by the Electric Machinery Manufacturing Company of Minneapolis, Minnesota. It is devoted to the subject of power factor correction with capacitors (static condensers). The title of the book is "Reducing the Cost of Electric Power" and gives a non-technical explanation of power factor and shows when and how to apply capacitors to reduce electric power cost. It also explains the construction of capacitors. This company has offices in all the principal cities where copies of this book may be secured, or from their main office at Minneapolis.

Cranes, Clamshells, Draglines, Skimmers, etc.—Write for Bulletin 45-D if desiring full information regarding the Universal-35, the new ½-yard machine of the Universal Crane Company. This is the 2-speed center drive crawler, a powerful rope crowd center drive shovel, readily convertible to crane, clamshell, dragline, skimmer, and backdigger. There is no obligation on your part in asking for this bulletin, just write to Mr. J. L. Beltz of the Universal Crane Company, 1324 E. 28th Street, Lorain, Ohio, for a copy, mentioning the name of our magazine.

Portable Flasher.—The Eveready Portable Flasher, is manufactured by the National Carbon Co., Inc., and when operated continuously the Columbia Dry Batteries should last two months. This is because the intermittent character of the load has been calculated to get the longest possible service from the battery. The operating cost of the Eveready Flasher is low, and the only attention required is the changing of batteries every two or three months. The National Carbon Company has offices in the principal cities, or they will be pleased to receive your inquiries at their New York office, 30 East 42nd Street, and will send you complete information in regard to this serviceable warning signal. If writing kindly give the name of our magazine.

Bituminous Heating & Distributing Unit.—Catalog KHD, issued by the Good Roads Machinery Co., Inc., Kennett Square, Pa., will give you complete details concerning their new Champion Bituminous Heating and Distributing Unit, for the application of asphalt and tar products. Write for description of this piece of equipment and then look it over at the Road Show. In addition to catalog KHD this company has a new catalog on sand and gravel KSG. Both of these catalogs will be found very helpful to persons interested in these fields. Booklets are profusely illustrated and contain useful tables. If writing for copies, please mention our magazine. Mr. J. W. Kitts is advertising manager and will be pleased to see that this literature reaches you.

Rock Drills.—The new Sullivan Rotator "L-8" is fully described in their new Bulletin 581-T. Write to Mr. S. B. King of the Sullivan Machinery Company, 76 East Adams Street, Chicago, for this booklet. The "L-8" features automatic rifle-bar rotation of the bit; improved steel retainer; automatic lubrication; automatic ejection of cuttings from drill hole; cushioned return stroke; adaptability to use on mountings; simplicity and convenience; drilling speed and power. Selected steels and Sullivan standard workmanship are employed in the perfection of these drills. If writing to Mr. King for information kindly refer to our magazine.

Calcium Chloride.—The Solvay Sales Corporation, have for free distribution a book on the use of calcium chloride in concrete construction. Their product, Solvay Calcium Chloride, is recommended for making stronger and denser concrete in any weather, but particularly for construction in freezing weather to insure profitable work. Much practical information is given in Booklet 6553. It is yours for the asking. Mr. A. T. E. Newkirk of the Solvay Sales Corporation, 40 Rector Street, New York, will be pleased to send it to you. If writing to Mr. Newkirk, kindly mention our magazine.

Asphalt.—The National Asbest-O-Phalt Corporation located in the Builders Building, Chicago, places the services of their engineering department at the disposal of architects, contractors and engineers for the purpose of investigating the uses of Asbest-O-Phalt in its many forms. There is also an office in New York to serve the eastern territory and one in San Francisco for the far west, as well as offices in London and Paris, for information concerning this modern chemical development of a product comparable with the natural asphalt of the ancients. If writing or consulting the National Asbest-O-Phalt Corporation we will appreciate it if you will give the name of our magazine.

Excavating.—A limited edition of a copyrighted piece of literature called "Excavating in Pre-Drained Wet Soils" is yours if you care to write to the Domestic Engine & Pump Company, N. Queen Street and P. R. R., Shippensburg, Pa., and request that a copy be sent to you. This booklet contains valuable information for engineer and contractor. We would appreciate it if you would mention our publication when writing for a copy.

Tractors.—Literature on the Atlas 4-wheel drive and 4-wheel steer tractors will be sent to you without obligation if you will write to Mr. C. W. Zimmerman, c/o The Atlas Engineering Company, Clintonville, Wis., mentioning our magazine. Particulars as to construction and performance will be furnished. This tractor is particularly well adapted for climbing hills, crossing ditches and pulling stumps and other heavy loads.

Floor Plates.—A new bulletin is now available describing the service of the Central "Knobby" Non-Skid Floor Plates, manufactured by the Central Iron & Steel Company, Harrisburg, Pa. These plates will stand the wear and tear of the most constant traffic. This company has offices in the principal cities, where information can be secured, or by writing direct to Mr. L. F. Nagle, Central Iron & Steel Company, Harrisburg, Pa., using the name of our paper.

Cresolac.—This is a transparent waterproofing preparation for brick, concrete, stucco, stone and plaster surfaces, and can be used without stain or discoloration. For full information concerning this product write to the Ceresit Waterproofing Corporation, attention Mr. F. A. Mitchell, 512 So. Canal St., Chicago. We would appreciate mention of our magazine if writing for particulars about this product.

Dredges.—Catalog E issued by the Norbom Engineering Co., Darby, Pa., gives full particulars concerning the Norbom Hydraulic Dredges. These dredges will be built to suit your special requirements. Write for a catalog giving the name of our magazine.

Textured Tile for Building.—The Clay Products Company, Inc., of Brazil, Ind., has just issued a very beautiful as well as authoritative text book on textured tile. It is a 60-page catalog, in loose leaf style, with cover and inside plates in nine colors. In presenting this catalog for the consideration of architects, engineers and builders, Mr. E. C. Gaertner, sales manager for the Clay Products Company states: "Textured tile is really a new type of building material, and we felt that architect, engineer and builder were entitled to a thorough treatise on the subject. We believe this is the most elaborate work of its kind that has ever been published." As rapidly as this field develops, additional pages will be sent to all the owners of the catalog to keep it up-to-date, which was the purpose in adopting the loose-leaf style of binding.

Bags.—Let the Bates Valve Bag Corporation, 35 Wacker Drive, Chicago, tell you about their multi-wall-paper bags in a very attractive folder which they have recently issued. These bags are proving of inestimable value to the contractor in protecting his plaster from losses by the elements. This company also manufactures the Bates Ties and Tools for the use of contractors in speeding up reinforced concrete work, by fast, tight, non-slipping ties requiring no special skill to apply. Write to this company for their latest literature, mentioning the name of our publication when writing.

Inertol.—This is a waterproofing and anticorrosive compound for impregnating concrete surfaces and for protecting steel, making the structures waterproof under pressure and immune against aggressive chemicals. This is manufactured by the Inertol Company, Inc., 253 Broadway, New York City, and stocks are carried in Newark, N. J., Chicago and San Francisco. In color it is a glossy black and comes ready for use, and needs no skill in applying, but is used cold with brush or paint sprayer. An illustrated broadside has just been received from this company giving the many uses for this product, prices, etc. Write to the manufacturer for full information, mentioning this magazine.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.

Municipal News and Water Works

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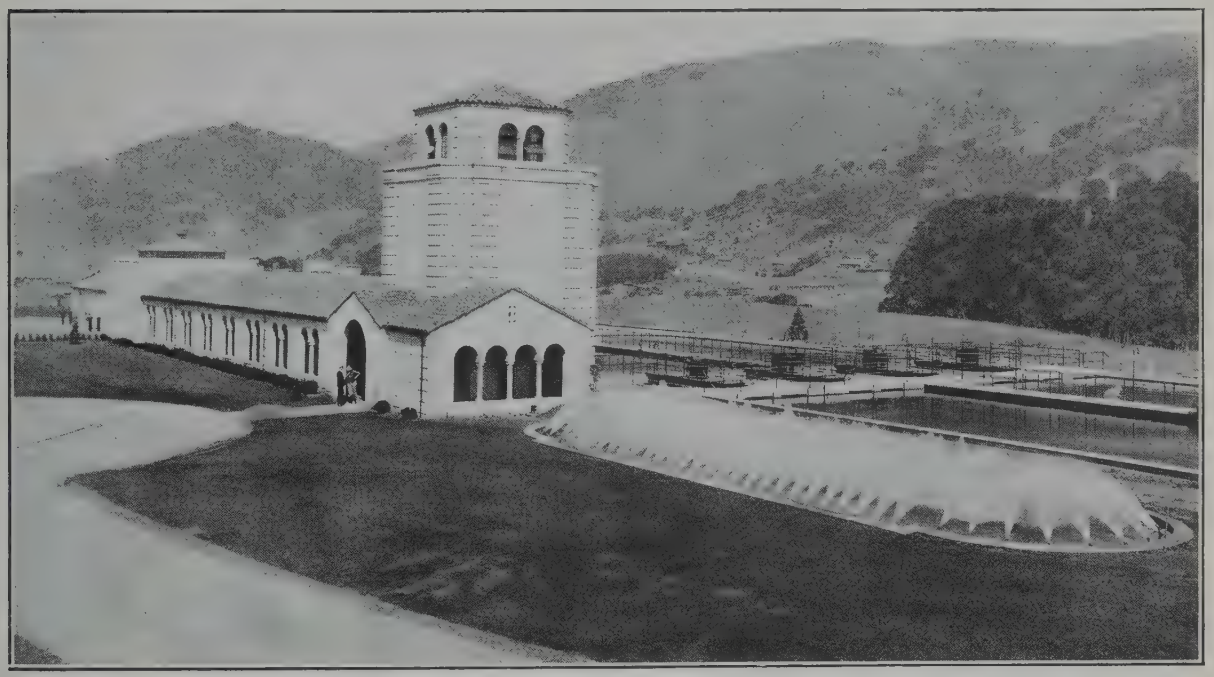


Operating Experiences With California Water Purification Plants

How Problems at East Bay Water Co. Plants Were Solved

By WILFRED F. IANGELIER

Associate Professor of Sanitary Engineering, University of California, and Consulting Sanitary Engineer, East Bay Water Co., and

JOSEPH D. DECOSTA

Assistant Sanitary Engineer, East Bay Water Co.

THE East Bay Water Co.* supplies water to Oakland and Berkeley, Calif., and other adjoining municipalities on the east side of San Francisco bay. The average daily consumption of water for 1927 was 32,000,000 gal., approximately two-thirds of which was filtered water from surface sources. There are two major filtration plants, the San Pablo plant, located just north of Berkeley, and the Upper San Leandro plant, 15 miles to the southeast in Oakland.

Raw Water Supplies.—Both plants are supplied with impounded waters of practically identical composition. The watersheds lie adjacent to one another and are of similar physical character. In general these waters are characterized by moderately high organic and mineral content and the reservoirs are subject to heavy growths of plankton or algae. The turbidities are flashy. During the heaviest run-off season, usually in February, the raw waters may attain turbidities of 2,000 or more p.p.m. Two weeks later the turbidities may have dropped to 25 p.p.m. and may not rise above this value for a full year.

The soluble and colloidal organic matter, mostly of vegetable origin, is continuously high. This is indicated by oxygen consumer values of approximately 10 p.p.m. and color of 40 p.p.m. A chlorine absorption test made recently gave a result of 70 lb. per million gallons, equivalent to 8.4 parts per million. These raw waters are capable of absorbing chlorine gas to upwards of 20 lb. per million gallons without causing taste or odor. That some of the organic matter is in colloidal suspension is indicated by the fact that the filtered water, although apparently clear, shows a marked Tyndall effect. It is practically impossible, with the use of ordinary alum dosages, to reduce the color to less than 15 parts per million.

The hardness of either water is slightly greater than its alkalinity and averages 3.5 milli-equivalents per liter or 175 parts per mil. The equivalent Sodium-Magnesium-Calcium ratios are approximately 1.0, 1.25, 2.25, and the Chloride-Sulphate-Bi-Carbonate ratios 0.75, 1.0, 2.75. The reaction of the water is slightly alkaline, pH=7.6.

The watershed lands that produce run-off water of this character are only sparsely wooded. Possibly 25 per cent

*The properties of the East Bay Water Co. have been taken over by the East Bay Municipal Utility District, which now operates them.

of the land is forested. The top soil is mostly clay. The lands are 70 per cent owned by the company and the density of population is very low, so human pollution is a negligible factor in the purification process. In 1927 only 10 per cent of 1,200 ton c.c. portions of raw water tested were found positive for M.R.+organisms of the Colon group.

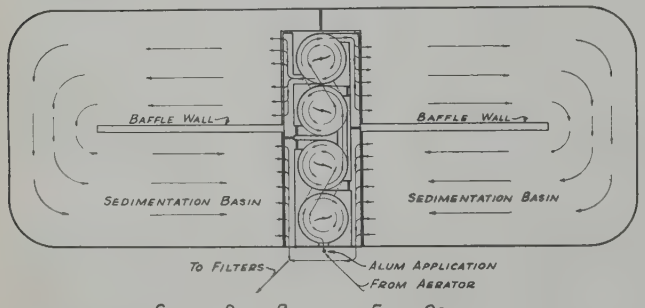
Other characteristics of the raw water which relate to the problems of purification are the seasonal presence of Plankton growths, more particularly the blue-green types of floating algae, and traces of Manganese, both of which may be very troublesome in connection with filtration.

Plankton Growths.—In this region, plankton or algae, if permitted, may grow abundantly the year around in practically all storage and open distributing reservoirs. In our storage reservoirs, where in many instances not more than 50 per cent of the water is replaced annually, the growths may be exceptionally heavy. Throughout the winter and spring months the plankton consists most of Crustacea and Rotifera and seldom exceed 10 p.p.m. by volume. Beginning in May or June, however, the sudden development of certain forms of Cyanophyceae may exceed 39 to 40 p.p.m., and if not controlled, may remain until October or November. Peak growths as high as 200 p.p.m. have occurred.

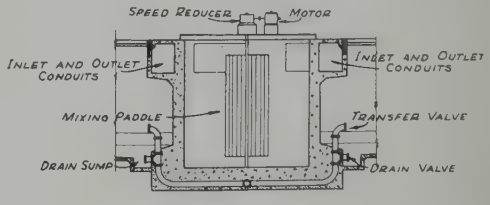
It has not been the practice to treat these stored waters with copper sulphate. The cost of such treatment, if given frequently in reservoirs holding upwards of five billion gallons, would be considerable, and since even the Blue-Green algae do not produce tastes and odors which survive the treatment process afforded these waters, coppering, up to the present time, has not been considered necessary.

In addition to the Crustacea which are present in varying density throughout the year, the predominating and most characteristic organism in the storage reservoirs is the Blue-Green alga Apanizominon. This organism has made its appearance each year and when the growth is at its peak a scum forms on the quiet waters around the margin of the reservoir which in places may be ¼ in. thick. Away from the shore the large masses are broken up by wave action, but the characteristic tiny clusters may be seen with the naked eye. Although this organism is reputed to impart to water a characteristic grassy taste and odor, our experience indicates that in the supplies under consideration taste and odor production is negligible until the organisms are undergoing decomposition. At such times the moldy odor, commonly associated with decay of vegetable matters, is usually noted. During periods of heavy growth, the removal from the water of the organisms themselves may add a heavy burden to the filter units. This burden is considerably lessened by excluding, from entrance into the intake, waters from the upper strata of the reservoir. These organisms do not penetrate, in large numbers, depths below 25 ft. except on very windy days. Treatment of the water at the intake with chlorine kills the organisms, but such treatment has not proven to be an advantage. Only a small portion of the organisms either dead or alive can be removed in the sedimentation basins after coagulation. When these growths are heaviest, the salvaging of the wash water from the filters, as ordinarily practiced, is dispensed with.

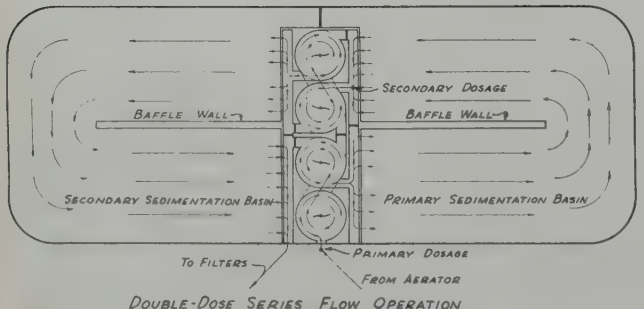
In the uncovered distributing reservoirs much algae trouble has been experienced in the past. We have found that during the summer and fall months dosing with copper sulphate, at regular intervals of about four weeks, is essential to the elimination of taste and odor complaints. Such treatment, moreover, not only prevents the periodic development of taste producing algae, but improves the appearance of the water by the destruction of brownish nannoplankton which otherwise would be present almost continually. It appears also that these treatments exert a cumulative effect in reducing materially the larger aquatic vegetation which formerly developed in some of the larger reservoirs. The elimination of nannoplankton requires a rather large dosage of copper sulphate. On a few occasions we have added as much as 15 to 20 lb. per million gallons of water. It seems that copper sulphate is less toxic to these smaller organisms. The effectiveness of chlorine in the destruction of



SINGLE-DOSE PARALLEL FLOW OPERATION



SECTION OF MIXING TANK



DOUBLE-DOSE SERIES FLOW OPERATION

EAST BAY WATER COMPANY
OAKLAND CALIFORNIA

COAGULATION AND SEDIMENTATION UNIT
UPPER SAN LEANDRO FILTRATION PLANT

Coagulation and Sedimentation Unit of Upper San Leandro Filtration Plant

bacteria would indicate the possibility that such treatment would be more effective than copper sulphate in the destruction of these smaller algae, but we have, as yet, no conclusive data on this matter.

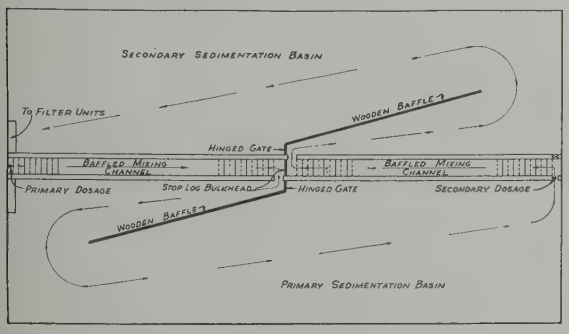
Filter Sand Troubles.—Within a few months after the San Pablo plant was placed in operation in 1921, a dark brown or almost black discoloration of the sand grains in the filter units was observed. This indicated the possible presence of manganese in the raw water and analyses confirmed this suspicion. The manganese content was found to be quite small, however, being somewhat less than one-tenth of a part per million. Realizing the damage that might result from permitting a manganese-bearing water to enter the distribution system, and also realizing the effectiveness of manganese-coated sand in removing manganese from water, it seemed desirable not to interfere with its further deposition. The discoloration and subsequent incrustation of the sand began at the top of the bed, where lay the finest sand, and gradually worked downwards. The first indication of any unfavorable effect was observed in connection with filter washing. The incrusted sand showed a marked tendency to cake, thereby causing the wash water to jet through the sand unevenly. In the course of a few months it became necessary to thoroughly prod the beds with rakes while admitting wash water. The condition of the sand kept getting worse until, in the summer of 1923, two years after beginning plant operation, under water cracking of the sand beds in very serious form occurred. At this time the upper 6 in. of sand had accumulated a heavy coating, equivalent to 20 per cent by weight. The amount of incrustation decreased with depth, averaging only a little over 1 per cent for the bottom 6 in. Analysis of the dried incrustation showed it to contain: Organic Matter 60 per cent, Aluminmum Oxide 26 per cent, and Manganese Dioxide 11.5 per cent. Describing this condition at the time, it was stated:

"The incrustation as found on the sand grains when a filter is drained is heavily hydrated, and when the sand is compressed in the hand the feel is like that produced by squeezing a handful of granular cork or rubber. The wet sand is also very plastic, so much so that a rod forced into the sand to the gravel layer, upon withdrawal will leave a perfect impression. If the wash water is then turned on, a jet will be formed at this point."

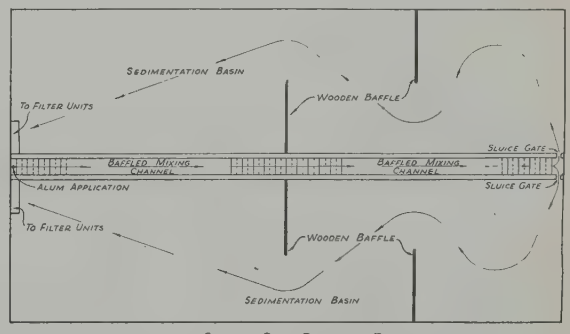
Much has been written concerning filter sand incrustation and filter bed cracking, which is sometimes associated with it. Our observations lead us to believe that filter sand incrustation may develop regardless of the character of the sand, provided the water is of a certain character and contains essential constituents, as for example, traces of manganese, colloidal calcium carbonate, suspended organic matter, etc.; and that cracking may occur if the coated sand is sufficiently compressible and subject to vertical stratification with relatively incompressible clean sand from underneath and brought to the surface by the jetting action of the wash water. We believe that the cracks are formed by unequal settlement of the sand bed, and that having once formed are subject to enlargement as a result of lateral compression of the vertical filtering surfaces. The correctness of this theory was indicated by frequent examinations of the sand on opposite sides of a crack and also from the observation that when a filter was drained immediately after washing, small cracks were formed upon standing, and always in a plane of vertical stratification.

It occurred to us that a system of washing more effective than the high rate water wash and the temporary experient of hand raking would be desirable. These units are designed with perforated pipe underdrainage and it seemed a very simple matter to adapt them to supplementary air agitation. It was assumed that a preliminary blowing of air through the bed would loosen the compacted sand and permit of a better wash water distribution.

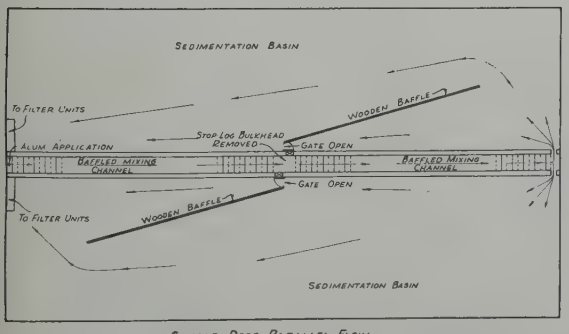
Accordingly, a complete unit was dismantled, the laterals carefully leveled, and the central manifold tapped to admit air. This unit was operated through a full season with excellent results and complete freedom from cracking. The following year the remainder of the units were treated in a similar manner. Since the introduction of air applica-



DOUBLE-DOSE SERIES FLOW OPERATION



SINGLE-DOSE PARALLEL FLOW



SINGLE-DOSE PARALLEL FLOW

Diagram Showing Alterations to Coagulation and Sedimentation Unit of San Pablo Filtration Plant

tion preliminary to the water wash, we have not once observed any cracking of the sand.

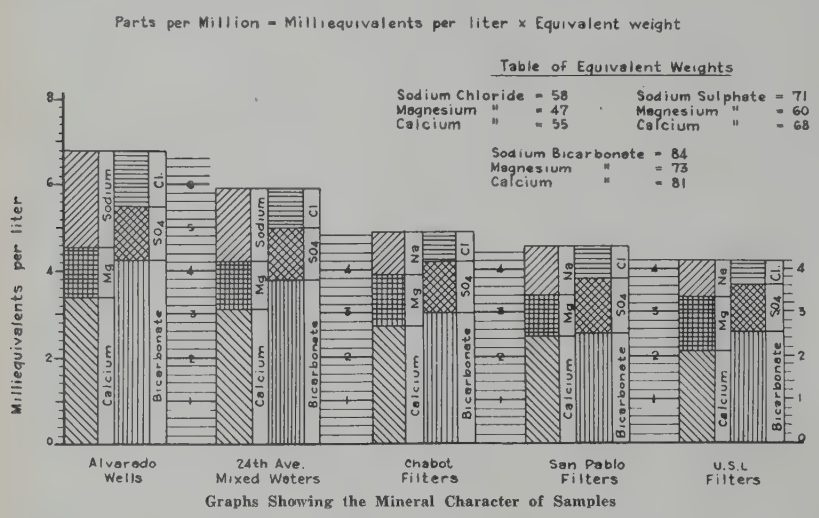
With this experience as a guide, the newer Upper San Leandro plant was designed for both preliminary air application and high rate water wash. We are convinced that air application is a cheap and effective method of preventing filter troubles caused by sand that has become plastic through coating of the grains. We have observed that the application of air in this manner does not materially agitate the sand. Its effectiveness depends upon a mere piercing of the plastic sand directly above each orifice such that the water may loosen subsequently the entire bed.

In this connection, it should be noted that the successful distribution of air through perforated pipe drainage laterals requires that they be set perfectly level. Studies made with separate laterals submerged under water showed that a difference of elevation of ⅛ in. at the opposite ends of a 14-ft. lateral was sufficient to impair distribution.

In the matter of manganese deposition, however, we are still perplexed with at least one phenomenon. Whereas at the San Pablo plant the fine sand at the top of the bed was the first to become coated, at the Upper San Leandro plant the gravel became coated before any of the sand was affected. We are unable to explain this definitely at the moment, but we suspect that it has to do with bacterial activity influenced by oxygen potential. In the latter plant the admission of air preliminary to washing may have been sufficient to maintain aerobic conditions in the gravel layer. At the San Pablo plant a gradual depletion of the dissolved oxygen content of the water, as it passes through the sand bed, indicates aerobic activity in the upper sand layers where the deposition occurs. One other condition surrounding these experiences is the fact that at the San Pablo plant the gravel was found to be quite heavily incrusted with iron oxide resulting from corrosion of the steel underdrains. It is well known that manganese oxides are not readily precipitated in the presence of ferrous iron. At the Upper San Leandro plant the underdrains are of brass tubing and iron deposits in the gravel are absent.

Salvage of Soiled Wash Waters.—The high cost of raw water development in this locality is such as to warrant the salvaging of soiled wash waters. This is accomplished at both plants with the use of suitable storage basins and pumping equipment. At times of excessive plankton growth, it is necessary to waste some of these waters for short periods each year. We estimate, however, that upwards of 95 per cent of these waters are redeemed, and this at a very considerable saving in water development costs. Throughout the greater part of the year the quality of this water after sedimentation compares very favorably with that of the original raw water. We believe that the ideal basin should provide a capacity equal to the wash water production for 24 hours, the return of the water to be distributed over a period of about 12 hours.

One item of interest in this connection relates to the problem of preventing accumulations of Crustacea which are not removed by sedimentation and are not easily destroyed with an algaecide. For a time this gave us some trouble until we hit upon the idea of their destruction on the filter beds by desiccation. This is accomplished by draining the filter unit and keeping it out of service for several hours. After such treatment the dead organisms are easily removed by sedimentation in the storage reservoirs. Where filter capacity is limited, it is believed that spraying the drained filter surface with an algaecide would accomplish the same result instantaneously; we have not, however, had occasion to give this a trial.



Graphs Showing the Mineral Character of Samples

Coagulation and Sedimentation.—The San Pablo plant as originally designed and built was found to be somewhat inadequate with respect to coagulation and sedimentation facilities. It was found that the highest turbidities occurring from three to four weeks each winter could not be lowered to the point of yielding a perfectly clear filtered effluent, even when the plant was operated at one-half capacity. This is believed to have been due to a variety of causes.

The coagulation and sedimentation unit as originally designed comprised two rather long rectangular basins, separated longitudinally by a shallow mixing channel, equipped with the usual "over and under" type of wooden baffles. The arrangement was such that the sedimentation basins could be operated only in parallel. Short circuiting occurred in these basins to an abnormal extent, due partly to the absence of suitable and properly designed inlet and outlet facilities. Wing baffle walls were first experimented with, but the results were not altogether satisfactory. Later, laboratory experiments indicated the desirability of double coagulation and sedimentation for the preliminary treatment of this water. In 1924 the basins were temporarily equipped to operate in this manner. The results were so satisfactory that permanent alterations were later made.

The problem of converting the existing parallel flow basins into series flow with double treatment and mixing was solved in what we regard to be a rather unique and highly satisfactory arrangement. This can best be visualized by reference to the accompanying sketches.

The mixing channel was blocked off at the middle point. On opposite sides of this bulkhead and in opposite walls of the channel an outlet weir into each basin was made. Opposite these outlet weirs, and somewhat diagonally toward opposite ends of each basin, a wooden baffle wall was installed. With this arrangement the water is given a primary dosage of alum, after which it flows through one-half of the total length of mixing channel, is diverted into the primary settling basin, through which it flows in a gradually retarded velocity into the far end of the mixing channel, where it receives a second dosage of alum. The water then travels back through the secondary mixing channel toward the center of the unit, over the second outlet weir into the secondary settling basin, in which the path of flow is identical to that in the primary basin. Conversion of the unit to single dosage and parallel flow is accomplished by removal of the channel bulkhead and by closing the adjacent weir openings with stop logs, so that the water may travel directly to the far end of the channel. At this point in each wall a large weir has been installed to replace the original 24 in. sluice gates. A simple adjustment of each baffle wall, made possible by a

free hinged end, has the effect of converting a portion of each basin into two parallel flow compartments. Experience indicates that the baffles in this position are desirable in that they assist in preventing transverse currents.

These simple alterations were carried out at very small cost and have had the effect of greatly increasing the efficiency and capacity of the whole plant, especially during periods of high turbidity.

Tests of normal operation this past winter showed that with a raw water of 1,000 p.p.m. turbidity, a clarification efficiency of 90 per cent was obtained in the primary unit, and 80 per cent in the secondary unit, making a total reduction of 98 per cent, resulting in an applied water turbidity of 20 p.p.m. The alum dosages in the two units were 4 and 2 grains per gallon respectively. Unfortunately, at this plant the total available mixing period at normal capacity of the plant is only 10 minutes. A longer period would undoubtedly produce a more rapidly settling floc with a smaller alum dosage. This fact is indicated by laboratory experiment and from our experience in operating the Upper San Leandro plant, where a mixing period of 25 minutes is provided. This latter plant has been in operation but little over a year. It was designed with the San Pablo experiences in mind and we are pleased to say that it is functioning excellently and in complete accordance with our expectations.

Circular Coagulation Tanks at Upper San Leandro Plant.—Circular coagulation tanks with mechanical stirring, used originally at Sacramento and in a slightly modified form at this plant, constitute perhaps the most interesting feature of design. These units differ from the Sacramento units more particularly in the matter of the ratio of paddle width to tank diameter. In the Sacramento design this ratio is 0.9, whereas in the Upper San Leandro plant the ratio is 0.24.

Paddles of this type have a lower starting torque and permit of much lower gear reduction. They are particularly well adapted to small units, since in these the paddle tip velocities are not excessive. Studies of these ratios with respect to hydraulic characteristics and other operating features are in progress and will be discussed in a later paper.

The high coagulation and sedimentation efficiencies at the Upper San Leandro plant are an important factor in reducing the burden on the filter units to a minimum. The average dosage of alum used at this plant for the entire first year of its operation was .89 grains per gallon as compared to 1.73 grains per gallon at the San Pablo plant. Applied water turbidities moreover were lower, averaging 10 and 15 parts per million respectively.

The mechanical mixing devices and exceptionally large waterways at the Upper San Leandro plant permit of a practically neglibible loss of head in the coagulation and sedimentation basins. Actual measurement at the rated capacity of the plant shows this loss to be only 1 in. The San Pablo loss of head with present baffling is 16 in., which at actual cost of pumping of 7 ct. per foot, per million gallons, would be $1.13 per day for the rated capacity of the plant. Electrical input at the Upper San Leandro plant for the four units is 3.6 hp., equivalent to $1.03 power cost per day also based on the same and actual rate for power. Although the costs are roughly equal, it should be noted that the mechanically operated units provide a retention period 2.5 times greater. Moreover, the mean velocities in these units are higher, averaging 1.3 ft. per second as compared to 0.8 ft. per second for the gravity mixing channel.

Chlorination.—All filtered water is chlorinated, primarily as a safety measure, because even the raw waters fall within the U. S. Public Health Service Standards throughout most of the year. The dosages vary from 2.5 to 8.5 lb. per million gallons and are controlled by frequent Tolidin tests. Our operators try to maintain between 0.50 and 1.00 lb. of residual chlorine per million gallons, ten minutes after application.

One ton chlorine cylinders have been in use since November, 1926, and we believe them to be the safest, cheapest and most reliable form of container for plants or groups of plants within a trucking radius of each other using a minimum of about 30 tons of chlorine per year.

Acknowledgment.—The above is an abstract of a paper presented at the San Francisco convention of the American Water Works Association.

Proper Disposal of Farm Sewage Important to Health.—Farmers' Bulletin No. 1227-F, entitled "Sewage and Sewerage of Farm Homes," reissued recently by the United States Department of Agriculture, warns against the dangers to human health and to livestock of negligence in properly caring for all forms of farm sewage. Details and illustrations are given for construction of approved privies, chemical closets and septic tanks. Suggestions are also made for the proper placing of them on farms so they will not drain toward wells. The use of disinfectants and deodorants is also explained. Proper care of the kitchen sink drainage is urged and illustrations show methods of disposal. The placing and construction of cesspools and grease traps are also discussed. Methods and details of construction are explained and illustrated in such a way as to be understood by homeowners. Copies of the bulletin may be obtained by application to the Office of Information, United States Department of Agriculture, Washington, D. C.

Pipe Line Inlet Air Valves

By J. W. LEDOUX
Consulting Engineer, Liberty Trust Building, Philadelphia, Pa.

In the July, 1926, issue of Water Works, the writer presented a paper on "Pipe Line Inlet Air Valves." Two very important experiences—one occurring in 1922 and the other during 1928—are convincing that there is a vitally important application of inlet air valves, or equivalent, that was not suggested in that paper.

The first experience was a number of serious breaks that took place on a 36-in. line, the cause of which was diagnosed as "water-hammer" due to a draft on the pipe line at a low point at a greater rate than the pipe capacity on the flatter grade above, causing the pressure on the flat grade to be reduced below the atmosphere, and the consequent parting of the column of water. When the draft on the line decreased, the upper column of water came in contact with the slower column of water in the lower part of the line, causing an enormously increased pressure, which broke the pipe. This experience was repeated five times within a year, and the pipe broke at different places not more than half a mile apart.

The remedy suggested was a surge tank at the point where the grade changed, and after this was installed no further breaks took place.

The writer was called in on a very similar experience in another part of the country where a 36-in. main had broken six times within four or five months. He diagnosed the cause to be the same as previously, and in this case, to avoid expense, advised combined automatic inlet air valves and outlet air valves. The first was to let in air as soon as the pressure was reduced to the atmosphere, which would provide an air cushion to prevent diastrous increase of pressure due to two columns of water coming together. The outlet air valves were necessary to relieve the line from air and permit the normal flow to be maintained.

This application of automatic inlet and outlet air valves is extremely important and they should be installed in a great many places where such conditions are possible, and may save the immense cost of surge tanks.

New York City Has 16 Garbage Incinerators.—New York now has 16 garbage incinerators in operation, located: three in Manhattan, two in Brooklyn, eight in Queens, and three in Richmond; three more are under construction in Brooklyn, and four more new incinerators were approved by the board of estimate and apportionment in November. It is expected that upon the completion of all—a total of twenty-three plants—the dumping of the city's garbage at sea may be entirely eliminated.

Cleaning a Water Main

Ice Plugs Used to Remove Soft Substance

By G. E. SHAW
Manager Chilton Hills Spring Water Co., Aylesbury, England

WHEN carrying out repairs or alterations on a public water supply system, the difficulties encountered are usually increased by the fact that, if the supply be curtailed, even to a slight extent, some of the consumers will lodge complaints. Perhaps, therefore, an account of a problem which had to be solved, without interfering with supply, by the Chilton Hills Spring Water Co. will be of interest.

Recently it became necessary to clean a length of 14-in. main which had become considerably choked by deposit. The main, which is shown in plan and profile in Fig. 1, runs from a service reservoir A to a point K, some 1¾ miles across country. All the water passing into the service reservoirs A and B is previously softened by Clark's lime process, and sometimes the water coming from the softening tanks is slightly grey, owing to the presence of minute particles of a flocculent nature. These particles, which have a specific gravity practically the same as that of water, remain in suspension in the water until they touch the walls or columns, when they appear to adhere to them tenaciously, but do not harden. The particles which are not arrested in this manner, enter the 14-in. main, and when they touch the sides of the pipes they adhere to them. In that way the main had become much clogged.

It was at first thought that the heaviest deposit was in the low-lying portion of the main, near the point F in the drawing, and in the hope of removing it, a wash-out had been inserted at the point K at the far end of the main. Although, however, that valve discharged the water faster than the main could bring it down, no great amount of deposit was washed through, which was taken to show that the deposit was in the upper part of the main, that is, between the points F and A, and that other measures would be required to remove it.

As a commencement, a 1-in. gas tapping hole was bored in the main at E, and on inserting a candle on a wire into that hole, it was found that the interior of the pipe was coated evenly all around to a depth of 2½ in. with a soft chalky substance.

It would, of course, have been possible to remove the deposit by means of the usual type of scraper, but there was hesitation in using a scraper, for, in the event of its sticking, the water supply of the whole system would have been cut off until it was removed. As the main was, in some places, as much as 16 ft. below ground level, it would have been a lengthy undertaking to open the ground and cut out the scraper if it happened to stick in any of those places.

It was therefore decided to clear the main by using plugs of ice which would melt if they did happen to stick. The main was, accordingly, cut at the points E and G, and a hatch-box was inserted at each place, a 14-in. valve being at the same time inserted at H. The point G was chosen for the insertion of a hatch-box, as it was a little way up a hill side, and, by cutting a channel at the lower end of the excavation, water and debris issuing from the hatch-box could be discharged into a valley at the foot of the hill, so that no pumping would be required to keep the excavation clear of water.

It may be explained that, before starting operations preliminary experiments had been carried out at the works with a short length of 10-in. main. A 10-in. diameter plug of ice, which had a 1-in. diameter hole formed through it from end to end, was employed. The 1-in hole was formed because it was thought that it would be necessary to have a flow of water through the plug so as to wash away the debris as it was scraped off the sides of the main. It was found, however, that the flow of water through the hole speedily melted the ice, so that the plug became disintegrated in traveling some 200 ft.

For the actual work of cleaning the 14-in. main, it was therefore decided to use solid plugs, 14-in. diameter, and they were made 4 ft. long. There was a doubt at first as to whether (a) the debris scraped off the pipe would pack in front of the ice block and choke the pipe if the block were allowed to travel too slowly, or (b) on the other hand, the plug would melt quickly if allowed to travel too fast. It was decided, however, that it would be safer to let it travel faster rather than slower; but, as an aid to keeping down the temperature, and lowering the speed of melting, about 5 cwt. of broken ice were inserted in the pipe from each end of the hatch-box E. A 14-in. plug of ice, 4 ft. long, was then inserted in the hatch-box and the cover put on. The valve H had been closed and the cover of the hatch-box G had been removed while the ice was being inserted.

In order to carry out the work of clearing the main at a time which would cause the least inconvenience, operations were begun late one evening when the demand on the system was low. The valve at A was therefore opened at 10 p. m. As a result, the plug of ice was driven through the main to the hatch-box—a distance of over 3,000 ft. —in 10 minutes. After the water had been allowed to run through the main for a further few minutes, it was shut off, a second plug was then inserted in the hatch-box E and the operation repeated, the valve A being closed after a 20-min. flush.

It may be explained that when the main was cut to insert the hatch-box G the coating inside the pipe was found to be 1¼ in. all around, but after draining the low part of the pipe by means of the scour valve shown on the drawing, an acetylene lamp, passed along the main on tubing from G in the direction of F, showed the black of the Angus Smith coating for 300 ft.—the furthest distance that the lamp could be passed up the main—which proved that, for that length, at any rate, the main had been effectively cleared.

At 11 p. m. the valve F was closed, ice was inserted at G and the wash-out valve K and valve H were opened. While that was being done the main between F and A had become charged to its full pressure. The valve F was then opened, and the ice and debris was flushed through the valve K, a distance of nearly 5,000 ft., and discharged there, the operation being completed at 12:30 a. m. The whole length of the main from the reservoir A to the wash-out valve K was, therefore, cleaned in 2½ hours.

On visiting the site next day it was estimated that about 20 cart loads had been discharged at G—of which 14 cart loads were actually scraped off the grass and removed—and from 6 to 7 cart loads had been discharged at K. Judging from the portions of ice discharged, the writer arrived at the conclusion that 4,000 ft. is the maximum length that can be efficiently scraped by means of ice plugs, but that it would be possible to scrape a longer length by using a plug made of sugar of a similar consistency to that of hard boiled sweets, which would take much longer to dissolve than ice would to melt.

Acknowledgment.—The foregoing is taken from the Dec. 28 issue of The Engineer, London, England.

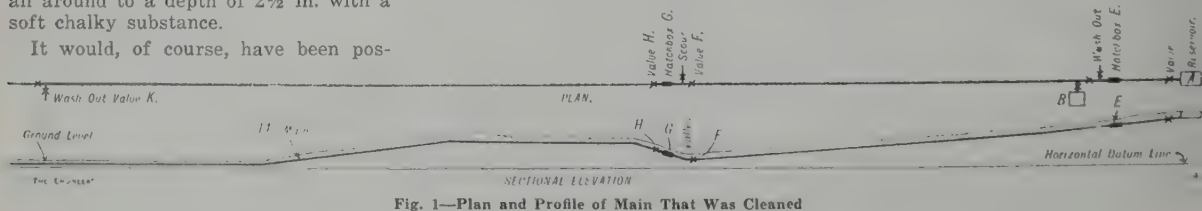


Fig. 1—Plan and Profile of Main That Was Cleaned

City Engineers' Problems Discussed at Cleveland Convention A. R. B. A.

Important Reports Presented by City Officials' Division

The Objects of the City Officials' Division

An Outline of What Is to Be Done

By CAPT. H. C. WHITEHURST
President City Officials' Divison; Assistant to Engineer Commissioner of Washington, D. C.

THE officials of the American Road Builders' Association, realizing the necessity for closer cooperation and greater standardization in the municipal highway field, organized on June 8, 1928, the City Officials Division. This division will doubtless fill the greatest existing gap in the highway industry.

It is through this division that municipal highway engineers will be afforded the opportunity to meet for an exchange of ideas and a study of new developments and methods. The advantage of conferring with manufacturers, contractors and others from every section of the country will be of inestimable value to all of us, and we trust every city official will endeavor to cooperate with us in our plan to improve municipal highway conditions.

It is my belief that every city should have a representative actively engaged in the work of this division.

Four Hundred Million Dollars Spent Yearly for New Paving.—The extent of the municipal highway activity is difficult to realize. No accurate figures as to the total yardage of pavements or improved streets covering all cities of the United States have ever been compiled. It has, however, been conservatively estimated that the total exceeds twenty billion square yards. Reports and estimates of new construction undertaken during 1927 indicate a total expenditure of over $400,000,000 for roadway paving, to which must be added $100,000,000 for maintenance. These figures do not take into account the expenditures for alleys, sidewalks, grading, roadway replacement and other municipal highway projects, such as street widening, bridges and grade crossing elimination projects.

Four General Committees.—The division has been organized into four committees for the work, as follows:

1. Organization, Administration and Finance.
2. Design and Construction.
3. Maintenance.
4. Traffic.

Each of these general committees has been divided into various sub-committees; however, for the first year, pending a survey of the municipal field and a broader acquaintanceship with those who will cooperate in the work, the general committee chairmen will develop the subjects for study by presenting at this convention an outline compilation of practices and thoughts for further study. The subjects under the several general committees cover practically the entire municipal highway and traffic field.

To me, however, under each of these committees there are outstanding features worthy of special consideration and thought mainly because of the past neglect, not only in the city I represent, in the city in which you are interested, but in 95 per cent of the other cities of the United States.

Organization, Administration and Finance.—Committee No. 1 deals with organization, administration and finance. I have found in my study of this subject that the methods employed in various cities differ to a marked degree. Of course, many of the methods are due to charter of state laws, and undoubtedly the systems in use serve in most cases, the purpose. There is, however, one neglected activity under study by this committee which is not controlled by basic laws and is vitally essential to the efficient and economical operation of any city street or highway department, no matter how organized or administered. I refer to cost records. You would be surprised to know that few cities of hundreds we have been in touch with keep any cost records, as we understand the term. Some have records of labor and material, but only a very few can give you accurate cost data of various operations. Without these, how can we compare methods, how can be say we are operating economically, or how can we be assured that we are getting the most out of our appropriations? Do we want to know? It may be like the man who owns an automobile; he doesn't want to know. Cost data are essential to the proper and efficient management of a municipal highway department; without it who can say when pavement and plant replacements are to be made or decide dozens of other questions? If such records were available over a period of years and the repairs of a certain kind were costing twice as much in Cleveland as in Chicago, your engineers would want to know why—without such figures, accurately and honestly made, we go pounding on in the dark. A uniform system is preferable so comparison may be made.

Such records would not only guide the engineer in maintenance work, but materially assist the designing and construction engineer in the selection and design of types of pavements.

Design and Construction.—Committee No. 2 deals with design and construction. Not to minimize the testing, research and experimental work that has been carried on in this field with inestimable value to every engineer interested in highway work, there is one, as important, but neglected subject assigned for study to this committee—field control and inspection. Associations, research bureaus, federal agencies and others have given us data for design and construction based upon scientific research and experiments that guide both the state and municipal engineer in the right path in this field; however, not one has put forward an educational campaign to insure the proper construction. Leaving for the moment mistakes in judgment and of sub-grade conditions, I dare say 90 per cent of other failures of streets and roads are due to poor inspections and lack of field control, or improper maintenance, the latter a subject I will touch upon. We carefully investigate the qualifications of applicant for design and field engineering positions, spend thousands of dollars in preparing plans and specifications, much time and thought in the testing and selection of materials, and then turn the work in the field for actual construction over to men who oftentimes fail to carry out either the spirit or intention of the work, either through incompetency or neglect. I have recently examined the paving specifications of some seventy odd cities. While there are provisions in some I do not agree with, there is not a single one if properly carried out that wouldn't insure a reasonable good pavement for the purpose intended. A relatively short time ago, I had the opportunity of visiting fifteen cities of the larger class and three state highway projects during the construction season. When I tell you that in eight of these cities there were no inspectors on the work, in four of them where inspectors were present they did not have nor had they seen the specifications, and in the remaining three, inspectors were present with the specifications but only two had read them, do we wonder why pavements fail. The state jobs were all well conducted with an inspector present and in each case he understood his work. These facts are almost unbelievable.

While I have for some time recognized the necessity and value of well trained inspectors, it so impressed me that I have given the subject since more thought than ever. Pavements are designed, specifications drawn and materials tested to provide and insure a predetermined strength in the structure. If construction is carried out in accordance with these instruments of service by the inspectors and engineers in the field, success will be attained in practically every case.

If men have to be employed in a city force for one reason or another, men untrained for the character of work in hand, incompetent or otherwise unsuited, don't put them in your inspection service, for if you do, the value of your engineers is partially destroyed and thousands of dollars invested in your construction jeopardized. Cities too small or whose work is not uniform so that they can maintain the nucleus of a good inspection force under a highly qualified chief inspector, would do well not to attempt to provide any inspection service but rather look to the established inspection bureaus for service, the services of which may be obtained at exceedingly low cost. Such service is vital to success.

Street Maintenance.—Committee No. 3 deals with the important subject of maintenance in all its branches. I am not going to attempt to go into detail on the operation of a maintenance division of a highway department, but I do want to bring out the importance of the necessity of keeping our streets in a high state of repair at all times, such being in the end the far more economical plan as well as providing better and safer traffic conditions.

Systematic maintenance with well defined policies will pull us out of the holes and result in far more economic operation, to say nothing of the comfort and convenience of the public. It takes a systematic procedure, a well balanced organization and sincere efforts. Do we want it? Is it worth while? The replacement value of paving and accessories of improved streets of the cities of the United States amounts to many billions of dollars—shouldn't such an investment be protected by proper maintenance—should highway maintenance, the right-of-way of the public, be carried on in a systematic and efficient manner the same as our principal railroads practice?

It is my belief that if sincere field control and inspection together with systematic and efficient maintenance were practiced today, failures of pavements would be reduced 90 per cent and in a few years result in large economy to municipalities. We condemn pavement design and materials unjustly instead of facing and stating our honest belief. I know of one city that has increased both the richness of mix and depth of base of the concrete for asphalt tops each year for the last three, attempting to prevent failure. Do you think the failure is due to design? What does the inspection cost?—probably less than 2 ct. per square yard, yet without any hesitancy the cost is increased 20 ct. per square yard by a change in specifications while everyone fears to increase the cost of inspection 1 ct. to correct the evil.

Traffic.—Committee No. 4 deals with the problems of traffic from many different angles. As a highway engineer, I am primarily interested from the standpoint of the use of streets, their capacity both as to volume and loads. The impression I have gained from my study of the traffic situation as related to a highway engineer's interest is the entire lack in nearly all cities of coordination of highway, traffic and public utility interests. The works of one are constantly upset by the works of another. There must be a closer and more cooperative spirit developed among these municipal activities if we are to succeed in our ultimate goal of service for the public. A highway system of a city may be likened to a railroad system in many ways. Where the arterial highways and main thoroughfares correspond to the main lines, the local or residence streets to the branch or secondary lines and the dirt or unimproved streets to sidings. In a railroad system each is constructed and maintained for the service intended. Is not the same applicable to a city highway system? To accomplish this, however, cities must zone or designate the street for use, design and maintain them for the service intended. Cities like railroads cannot, if for no reason than economic ones, construct all lines for maximum service and traffic. It is also true that railroad authorities design for certain classes of rolling stock which they control. So it must be with highway engineers or still greater losses may be expected.

If the City Officials' Division can accomplish no more than work out constructive suggestions for the benefit of cities to bring about the proper cost records, improvement in inspection service, systematic and adequate maintenance and a closer relation between traffic and highway authorities, it will have not only fulfilled its purpose and duty to the municipal authorities but will be the means of pointing out the way of saving millions of dollars to the taxpayers throughout our American cities.

Organization, Administration and Finance

Preliminary Report of Committee Presented Jan. 15 at Cleveland

By H. C. WHITEHURST

Chairman Committee on Organization, Administration and Finance, City Officials' Division

REPORTS, annual and special, were received from the highway departments of over sixty cities in the United States, and covered every state in the Union. They indicate many and varied methods of operation, administration, and financial procedure showing that to accomplish the same purpose there is no approach to standardization or the adoption of a uniform system. Due to this varying procedure, comparison is difficult. However, a compilation will afford a basis for discussion of the merits of the methods and will serve as an expression or guide to the sub-committees which may further develop the problem.

Six Major Subjects Considered.—The executive committee, after thorough study, tentatively divided the work of

the Committee on Organization, Administration and Finance into six major subjects as follows:

1. Organization.
   a—Cities of more than 300,000 population.
   b—Cities of less than 300,000 population.
2. Method of financing for new pavements.
3. Contract procedure.
4. Selection of types of paving and streets to be paved.
5. Financing and charges for street openings or cuts.
6. Cost records.

It is the intention of the executive committee to later develop each of these subjects through sub-committees, and to add other subjects which appear desirable.

Organization.—The organization of the highway departments of the sixty odd cities studied, indicate varied and detailed methods of control and organization. Generally speaking, their entire highway activities are centralized under one coordinating or directing head who is charged with full responsibility for administration, design, construction, maintenance and inspection. On the other hand, in some cities of the first rank, there is a division of authority and responsibility. In these, design and construction are under one chief and maintenance is under another, without a supervising and coordinating head over both. In this latter class of decentralized control is one of our larger cities, which has separate and independent boards; one controls construction and the other controls maintenance. The law under which the maintenance board operates prohibits maintenance repairs to more than 15 per cent of the street area. Consequently, if maintenance funds are not readily available the street is neglected until 15 per cent or more of its area is in need of repair. It then automatically becomes the burden of the board on new construction. As a consequence many streets with several years of life and which are worthy of economical repair are left to go to pieces until new construction can be undertaken.

Organization detail in cities must necessarily vary widely due to local laws and conditions. The work of construction and maintenance is so closely related that a division of authority cannot be economical or efficient regardless of the size of the city. While the resurfacing of an asphalt street by stripping the base or by the super heater method may be primarily called a maintenance operation, the construction division is usually better equipped to handle such operations. Many conditions could be cited to illustrate the desirability of and necessity for both branches reporting directly to a common active head.

Many cities while reporting the design and construction division as one, seemingly divide these functions. The peculiar operation of this division in the highway department of the District of Columbia may merit your consideration. The engineer in charge of the division of design and construction, in addition to his assistant construction engineer, is supported by nine assistant principal engineers, each in charge of a designated character of work. The assistant engineers are responsible for and execute the design of their own field work under the supervision of the assistant engineer of construction. They are responsible for design, field layout, co-ordination and general supervision. This organization has been found to operate satisfactorily by centralizing responsibility for results and progress.

Few cities attempt to maintain, as an independent unit of the highway department, an inspection division. Most cities, of any size, necessarily provide for inspectors in their organization but usually place them under the construction engineer in charge of the project. My study of this highly important phase of our work and organization has convinced me of the necessity in cities of sufficient size for an independent unit under a chief inspector who is responsible only to the bureau chief. Construction engineers, while interested in quality, are chiefly concerned with grades, progress and the like, while the inspector is or should be interested above all other things, in quality and compliance with the plans and specifications.

If a city on account of its size or the amount of work being performed annually cannot justify qualified annual inspectors, the employment of the services of an organized and qualified inspection bureau is necessary and justified. Without proper field control, inspection of materials, engineering and design goes for naught. Field control is the heart of your work, if it is inadequate failure is inevitable.

The organization charts of the highway activities of three cities are presented to show some of the variations in organization:

No. 1—A city of 200,000 population.
No. 2—A city of 500,000 population.
No. 3—A city of 1,100,000 population.

Method of Financing for New Pavements.—The usual procedure of financing for new pavements is through special assessment and bond issues. Local streets are financed by the assessment method and main arteries by bond issue, followed in some cases by partial assessment. Only in rare instances do cities report direct appropriation followed by assessment. This latter method is followed in the District of Columbia and reacts with great favor to the highway department, whose work for the season can thereby be well planned in advance. In new sections a great deal of paving is undertaken by private parties under the whole cost method; the work being performed under permits issued by the engineering department, which require that the work be carried out under current specifications and district inspection.

In the matter of special assessment for street improvements, in spite of its importance, very little study has been given to the subject; consequently there is little uniformity or standard procedure.

A study of assessment procedure based upon reports from twenty-six cities having each a population of 100,000 or more shows the following methods:

New Street Paving.—The method most used is the 100 per cent assessment of abutting property by the front foot. In some instances this method is not completely used as intersections and other exceptions are made. In ten cities paving costs including intersections are assessed. In eight, the paving, except intersections, is assessed. In two, the city pays for intersections plus 2 per cent of the remaining cost. In two, the assessment is to the extent of actual benefit and the remainder is paid by the city. In one, the abutting property is assessed for a 12ft. strip, the balance,

including intersections, is paid for by the city. In one, parkways and special traffic streets are paid for entirely by the city; on other streets the abutting property pays 100 per cent, less intersections. In two, assessment is based entirely upon character of street, varying from 20 per cent to 100 per cent.

Eighteen cities of those studied assess benefits on the front foot basis, one on the area basis, three use zones, and two a combination. In several cities, property on the intersecting streets for a part of the block, are assessed.

Washington's method is based upon the so-called Borland Amendment passed in 1914, which requires street paving to be assessed once only. Fifty per cent is assessed against the abutting property owners (25 per cent on each side) up to a width of 40 ft., less all intersections, and the balance, including intersections and widths in excess of 40 ft., is paid by the city.

Sidewalks.—In practically every city the entire cost of sidewalks is assessed against abutting property. In Cleveland and Philadelphia sidewalks are constructed and paid for by the property owner. In Washington 50 per cent of the entire cost is assessed (whole cost sidewalks are permitted when laid under district specifications and supervision).

Grading.—In fifteen of the cities studied, the cost of grading is assessed by the same method as paving, or included in the paving cost. In one, however, only sub-grading is included and general grading assessed against a benefit district. In ten cities, original grading is assessed either by assessment against abutting property or a benefit district created for the purpose. In two, one of which is Washington, there is no grading assessment.

Curb and Gutter.—In practically all cities the assessment for curb and gutter follows the paving assessment procedure.

Repaving.—Sixteen cities assess the same as for original pavements, however, some add special provisions as to age when replaced. Five cities make no assessment for repaving. In one, there is no assessment for repaving, if pavement is less than 15 years old. In one, cost of assessment is limited to $3 per yard. In Cleveland, the assessment is for 50 per cent of the cost. In one, two-thirds of the cost is assessed against abutting property. In one, one-half, and in one, one-fourth.

In Washington, pavement assessment can be made but once. Prior to 1914 there was no assessment. As the pavements so far replaced were laid before 1914, assessments are made as streets are repaved and at the same rate of assessment as for new pavements. If it is desirable to surface a street paved with concrete or block, and which had been previously assessed, the property cannot again be assessed. In the case of all street improvements, except paving of roadways, the law provides for advertisement for objection at a public hearing of abutting property owners. The board of commissioners determine after a hearing whether or not to overrule any objections and order the work to proceed in the interest of the public.

It appears that all cities use assessments in one form or another and that the usual manner of payment to the contractor for the work done is by one of two methods:

(1) By certificate of assessment, in which case the contractor assumes the responsibility for collection and suffers any loss of those that are uncollectable.

(2) By cash. The city obtaining the necessary funds partly from property owners, who pay when the work is completed, and partly from the sale of assessment bonds. Bonds are liens against the property, some cities guarantee them; some do not.

(Washington pays by cash appropriated directly by Congress. The cash funds are obtained from general taxes and the gasoline tax.)

The first method which is practiced in a great many cities where the 100 per cent assessment plan is used undoubtedly encourages and necessitates the contractor to increase his unit bid to cover anticipated losses.

The assessment for street improvement as applied to roadway paving was practiced years ago as a purely local benefit. When the laws were written undoubtedly such was the case, but today, except in the case of purely local residence streets, the extent of the local benefit is doubtful. Conditions, since the original assessment laws of most cities were passed, have materially changed. Roadways are designed and constructed today for general traffic requirements and only in a small part as local benefit. If our assessment laws are out of date, the time has arrived when a larger part of the pavement cost should be passed on to the user and the property owner relieved of some of his burden.

Contract Procedure.—Applying the term "contract procedure" to mean the method of letting contracts for street improvements, it is found that cities utilize the same general policy of letting a separate contract for each street whether the work is for one block or more. Several streets may be included in one letting but separate contracts made for each. This procedure is undoubtedly made necessary in many cases by law, but it involves enormous clerical and other work, judging by the number of contracts in each city during one year. In cities over 300,000 population, where considerable work is undertaken each year, the number of contracts for street improvements vary from 94 to 997. In cities with a population of 100,000 to 300,000, contracts vary in number from 21 to 180.

In Washington the system is so entirely different from other cities that it may merit your interest. Bids are invited at the start of the working season, usually in March, for each class of work. Projects are advertised in groups of sufficient size to constitute a season's work, except that a few minor contracts are made from time to time. Some of the contracts require completion by December 1 and some require a percentage of completion on that date. The balance of the contract being completed during the following spring by June 30, the end of the fiscal year. The exact dates are determined by our ability to pay and the size of the contract. The specifications are issued stipulat-

-ing the amount upon which bids will be scheduled. The statement is included that a list of streets from which work will be allotted the contractor is on file for his examination in the engineer of highway's office. The system has proven successful and has resulted in low bid prices as compared with those of several other cities. This method also insures continuous work during the working season and attracts contractors who have adequate organizations and equipment.

The qualification of bidders and contractors for executing important highway and street improvement in cities should receive the serious consideration of the sub-committee on contracts. The pre-qualification of bidders is practiced in some states while in others contractors are required to present satisfactory evidence of adequate experience, financial resources and equipment to execute the work successfully. Cities would do well to follow, in part at least, the requirements made by our states.

Selection of Types of Paving and Streets to be Paved.—The selection of the character of paving for various projects, certainly in all of the larger cities, is based almost entirely on traffic requirements. Generally speaking, the types, without reference to the design, have been generally standardized. Exceptions are the local or unimportant streets and the reclaiming of existing structures.

The procedure of selecting streets to be improved is similar. Cities follow practically the same course, namely, the improvement of main arteries and thoroughfares are selected by the board of improvement and the local streets are selected after reviewing requests and petitions of property owners and others.

Financing and Charges for Street Openings or Cuts.—The charges to public utility companies and others for repairing cuts or openings in improved streets are made on both the flat rate system and the cost plus system. Some cities use both. Washington, for example, is in the latter class and uses the flat rate based on published charges for replacing all existing types of paving and sidewalks when the area is less than 10 square yards. The cost plus system is used when the erea is in excess of 10 square yards. The percentage added where the cost plus system is used varies from 5 per cent to 15 per cent. Nearly all cities require a deposit in advance of permit. The whole subject of cuts, including replacement and repairs, is one in which all cities are vitally interested. I believe it merits the appointment of a special committee to study and report in detail on financing, charging, methods, repairing and inspection.

Cost Records.—Few cities keep or attempt to keep any detailed cost data. Some have records of labor and material, but only a few can give accurate cost data for various operations. Even those that attempt any system of accounting procedure are so vague as to details included in ascertaining the cost, that the reports are of little value. Cost data is essential and indispensable to the proper and efficient management of any municipal highway department. A uniform system of accounting would make comparisons possible, which would lead to more effective management and standardization of principles of operation.

In connection with keeping cost data as applied to roadway repairs it would be decidedly advantageous to have a corresponding record of area repairs, exclusive of cuts, for each type of paving.

In reviewing the subjects assigned this committee I have reached the conclusion that organization and selection of streets to be paved, are problems for the individual cities. Further detailed study will accomplish little but to furnish interesting data for comparison. The matter of assessment or financing for new pavements, contract procedure, financing and charges for cuts, and cost records, are in my judgment worthy of close study and investigation by subcommittees, one for each subject. An exhaustive investigation and study of the various practices followed by a report with specific recommendations will be of inestimable value to all city highway officials.

Pavement Design and Construction

Preliminary Report of Committee Presented Jan. 15 at Cleveland

By GEO. B. SOWERS

Chairman Design and Construction Committee; Deputy Commissioner of Engineering and Construction, City of Cleveland, O.

MANY millions of dollars are spent each year, by the cities of this country in the construction and maintenance of pavements, more money than is spent in any other one municipal enterprise. This tremendous expenditure is prompted and justified by the health and pleasure of the people and the economic demands of business. A city must provide and maintain a pavement in every street.

Much of the city paving work is still in an experimental stage. New designs, methods and materials are being adopted in different places without taking advantage of the experiences of other cities. Experience is expensive, and requires years of time to be acquired. No one city official has the time or facilities to gain personal experience on the service and merits of all the paving designs, or methods and materials which are available.

What better way is there for obtaining the accumulated experiences of many cities than through the work of the design and construction committee? Cannot our greatest service be through the accumulating and disseminating of the paving experience of cities? Factors of size of city; climate; kind of subgrade; the variety of machinery; the quantities and size of materials used, all offer most valuable fields of study.

The executive committee therefore thought it best to present a tentative outline of such a study as a basis for work during the coming year. There are no findings or conclusions in my report, but only suggestions which will be still further enlarged, I hope, by discussion. The executive committee has divided the tasks of the design and construction committee into seven major topics:

I. Contracts and Specifications.
II. Roadway Widths.
III. Subgrade.
IV. Pavement Bases.
V. Wearing Surfacing.
VI. Street Railway Tracks and Paving.
VII. Field Engineering and Inspection.

Let us take up each in turn and see what possibilities can be developed.

Contracts and Specifications.—First let us consider contracts and specifications because they offer an unlimited field for study.

I have found the standardization of specifications very interesting and profitable. Standardization and simplification of specifications will bring about the elimination of economic wastes, and permit the producers of paving materials to lower the selling price of their product through a reduction in manufacturing costs. They also allow the manufacturers of road building equipment to reduce the number of sizes of equipment, and thereby lower their costs. Standardization and simplification will therefore lower the final cost of the pavement to the public.

In the Cleveland metropolitan area there are a large number of independent municipalities. A few years ago it was realized that the same paving contractors and material dealers served all of the municipalities under many different specifications. At the instance of Mr. Hopkins, our regional vice-president and the city manager of Cleveland, the engineers representing the Cleveland metropolitan area met and adopted a uniform set of paving and materials specifications. These standardized specifications have proven to be very advantageous.

There are a great many national associations and boards working upon the standardization of paving materials. As the requirements for materials become standardized throughout the country, the combining of these ma-

terials into a pavement can be standardized.

Standard specifications advocated by an association such as ours, should be so prepared that each engineer can adapt them to his peculiar conditions.

Competition is an essential requirement in all specifications issued by municipalities. It is generally prescribed by law. How can paving specifications be written to use the new patented materials and processes, and at the same time permit competition?

The contract form and general provisions, as well as the more general part of the specifications are not well adapted to standardization. State laws, municipal ordinances, and local practices govern these features in each municipality.

Progress towards standardization will be slow and we must not expect too much this first year.

Roadway Widths.—Roadway widths are probably a function of city planning, but they generally are determined by the city engineer. If the street right-of-way is wide there is always the opportunity to use a liberal roadway width. Many of our street rights-of-way were fixed before the era of motors, and the paving engineer is limited to the width of the roadway that he can crowd into the existing right-of-way and still leave room for a sidewalk of reasonable width, together with a space for poles and fire hydrants.

In a city such as Washington, the roadway widths may be made more generous in order to carry out the picture of spaciousness, but in cities such as Philadelphia, where land is very valuable, the right-of-way is made the narrowest permissible, and the paving engineer must plan the pavement width with the greatest care.

On inter-city highways the general rule for fixing the roadway which seems to be 10 ft. of pavement for each line of moving vehicles, and 8 ft. for each line of parked vehicles. Does this same rule apply to the main traveled business streets of our cities where traffic naturally moves more slowly, or can a narrower width of lane be used with safety?

The width of traffic lanes around curves should perhaps be given study. The theoretical additional width required for a turning vehicle can easily be determined, but the proper allowance that should be made for the inability of drivers to keep within the curved lines of a traffic lane apparently has never been determined.

Subgrade.—The subgrade is one of the most popular paving subjects today. The study of soils in pavement subgrades is intensely interesting because of the great variety of soils and the many possibilities for improving the unsuitable ones. Subgrade soils range from the most perfect sand soils to the worst clay, silt or muck.

Each unsuitable type of soil requires a different treatment to meet different kinds of climatic and pavement conditions. As yet no certain rules have been found which will apply in every case. Much work has been done in the United States Department of Public Roads and the results of some of their studies will soon be published. Wonderful progress in soil investigation is being made in some of the state highway departments, but little study has been given to the subgrades in cities.

Instead of continuing to build thicker and stronger pavement bases in an effort to carry the increasing traffic loads over more or less unstable subgrades, it is more logical and economical to increase the supporting power of the subgrade. No economical thickness, or strength, of plain concrete will carry the loads of traffic over a subgrade which becomes unstable under certain climatic conditions. The only reasonable solution of this problem is the increasing of the supporting power of the subgrade.

The subgrade material in the City of Cleveland ranges from perfect sand to clays that heave and lose almost all of their supporting power at certain times in the year. In the clay areas of Cleveland the supporting power of the subgrade is being economically increased through the use of a 4-in. cushion blanket course of granulated slag under the concrete base, with plenty of drains to take the water from the porous layer. The past year has been the third season that this porous sub-base has been used. It has overcome considerable cracking of the surface and the pavements are carrying the maximum loads without failure.

The granulated-slag cushion blanket course has a tendency to cement together, forming not only a porous insulating layer, but also adding greatly to the strength of the pavement foundation.

The compacting of the subgrade prior to paving is another of the subgrade problems. Should not the soil under a pavement be left or placed in its natural condition, if it is to provide a uniform bearing for the pavement? If over compact, it will expand to its natural condition in the course of time and raise the pavement, and if undercompacted, it will gradually consolidate and settle away from the pavement foundation.

Some engineers believe that the subgrade should be rolled with a 15-ton roller, while others require only a 5-ton roller. The heaver roller finds all the soft spots and uncompacted trenches in the subgrade, but it may over compact compressible subgrades in spots. The result is that the subgrade material expands to its natural condition in the course of time, causing unequal support under the pavement foundation.

It frequently happens after the subgrade is fully prepared to receive the pavement that it is cut to pieces by the trucks hauling the concrete aggregate or the mixed concrete. This damage has been overcome in Cleveland by the requirement that no trucking shall be allowed directly upon the subgrade or cushion blanket course. Trucking is permitted only upon a plank roadway or equally effective method for distributing the load.

Pavement Bases.—Pavement bases cover a large field for study. The thickness of the concrete base for various kinds of surfaces and assumed load conditions is worthy of considerable study.

Many engineers believe that a concrete having a 2,000-lb. crushing strength is the most economical for pavement bases; others claim that cement should be added to produce a concrete having a 3,000 or 4,000-lb. crushing strength. If it is only a question of additional density or of waterproofing, the same results might be obtained through a waterproofing of the concrete, instead of using a mixture which is richer in cement and which therefore expands and contracts to a greater extent.

A 4-in. Granulated Slag Cushion Blanket Course on East Boulevard, Cleveland

The city of Cleveland's specifications produce a concrete having a crushing strength of between 2,500 and 4,500 lb. per square inch at 28 days. This is probably 1,500 lb. higher than was used 10 years ago. There is some question as to whether or not the resulting increased coefficient of expansion is the cause of many of the broken places in the pavements.

In some parts of the country, macadam pavements have been used quite extensively in city streets. The old macadam pavements have been resurfaced with bituminous mixtures and the resulting surfaces in many cases are highly satisfactory. There is no doubt a field for the use of macadam bases under bituminous wearing surfaces, but all the facts are not known.

Some study should also be given to the use of such foundations as black base, and the natural sand bases.

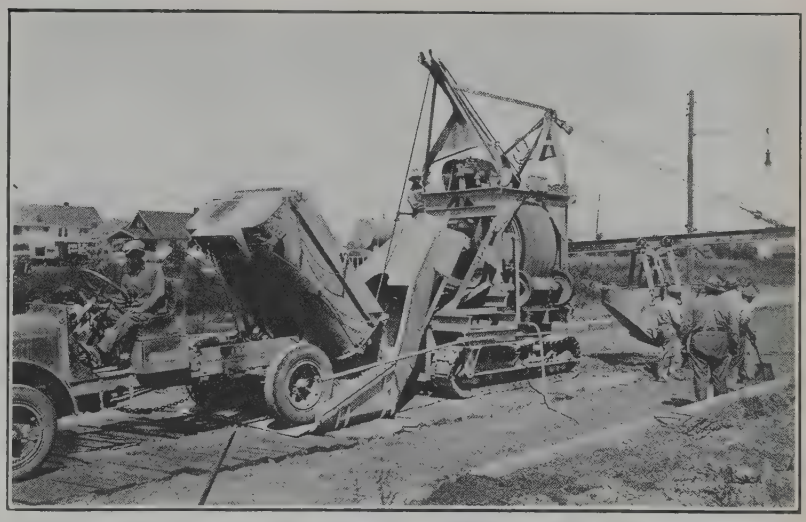
The Highway Research Board found that wire mesh reinforcement is advantageous in concrete roads because it reduced the width of cracks. Wire mesh reinforcement would probably be of value in pavement foundations. The city officials' division will make a comprehensive investigation of the question of pavement foundations, including the use of wire mesh reinforcement. Mr. Hogentogler of the Bureau of Public Roads, who conducted the survey on the use of reinforcement in concrete pavements, has consented to undertake the study of pavement bases. He is prepared to give a large amount of his time to this investigation.

The drilling of cores from pavement bases is a comparatively recent development. There is still much to be learned. Many city engineers do not believe that it is necessary, but Cleveland has found that it results in better and more uniform concrete foundations, both in thickness and strength.

Individually the cores drilled from pavement bases prove nothing, but collectively they give a good indication of what might be found if the entire base could be taken up, measured and tested. It is true that one little core taken from a length of pavement is a very small part of the whole, but obviously it is impracticable to examine the entire pavement base.

I believe that this committee can render a valuable service to the city engineers through the working out of a standard method for checking and testing the strength of concrete bases. All engineers desire uniform thickness and strength of the concrete, but they have not developed satisfactory methods for checking these items. Cores drilled from the pavements greatly assist in the solution of these problems.

The proportioning and grading of the concrete mixture and the consistency and workability of the concrete can all be more easily controlled at a central mixing plant. The resulting concrete has a more uniform final strength. There is also the possibility that the transporting of the concrete results in the elimination of air entrained in the concrete. This fact may account for some of the additional strength shown by the ready-mixed concrete. Warm concrete for use in cold weather construction is accomplished more easily with ready-mixed concrete than with concrete mixed on the street. Specifications should be developed to permit and control its use.



Planking on Subgrade on West Avenue, Cleveland

Many of the methods adapted to the curing of concrete roads in rural sections cannot be used in city streets. Ponding, earth covering or straw covering are some of the methods not practical in cities for obvious reasons. Sprinkling with water is probably the most common method used. Sodium silicate, asphalt spray and calcium chloride are being tried. Data and specifications for the use of the various curing methods would be welcomed by the city engineers I am sure.

Wearing Surface.—The wearing surface of pavements offers another unlimited field for study. The Bureau of Public Roads has found that the function of the top layer or wearing surface is to take the wear and absorb a portion of the impact from moving loads. Smoothness without slipperiness is one of the essential qualities of a wearing surface.

Time is an important factor in the paving of most city streets. Wearing surfaces which can be laid and opened to use in the shortest possible time have decided advantages. The minute a pavement is completed the public demands that it be turned over to them for use. The closing of one block in a built-up city means congestion in all adjoining streets, with a subsequent loss of business, and an increase of traffic and fire hazards.

The increase in the use of asphalt as a filler for block pavement surfaces has brought the problem of how to keep the asphalt from forming an unsightly and rough surface on the pavement during the first year after it is laid. Some asphalt fillers also become very sticky during warm weather. There are also asphalt fillers which become brittle and pull away from the blocks when the surface contracts, thereby defeating one purpose of an asphalt filler, namely, that of flexibility.

A non-skidding surface is one of the most desirable features of a pavement. Stone, vertical-fibre brick and some bituminous concretes present excellent non-skid surface. A cold-laid asphaltic mixture is being tried in the Cleveland area on hills having as high as 6 per cent grades.

The low annual cost and the ease with which it can be opened and replaced makes the sheet asphalt pavement surface very desirable for use on wide, heavily-traveled city streets.

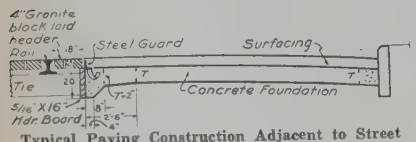
The plain and reinforced concrete pavements have proven very economical on rural highways. The use of concrete as a city pavement has not been as well developed. The finishing machines which have been so successfully used on rural highways have not been perfected for all classes of street paving, with the result that much of the finishing must be done by hand with consequent unevenness and over or under compacting and finishing. Study by your committee could do much to perfect the design and construction methods for concrete pavements.

Brick or stone-block gutters are used in many cities in combination with asphalt surfaces. There is some question as to whether these gutters are necessary or justified from the standpoint of cost. Some engineers claim that it is cheaper to use brick or stone gutters than to replace disintegrated asphalt gutters with new asphalt.

Street castings, manhole tops, valve boxes and catch basins are pavement details which require study and stand-

ardization. The improper setting of these castings results in holes and bumps, too many of these castings are designed solely from the standpoint of the public utility with no consideration given to the paving. We are very careful to obtain a smooth pavement surface, yet many city pavements are filled with street castings, each making a bump which is as undesirable as a hole in the pavement surface. The breaking of manhole and catchbasin tops is a continual source of damage claims in cities having heavy concentrated loads passing over the streets. Considerable study could well be given to the standardizing of street castings, their design and construction.

Street Railway Tracks and Paving.— The paving of the street railway tracks is closely allied to the construction of



Typical Paving Construction Adjacent to Street Railway Tracks, Cleveland

the tracks. Studies of track construction are being carried on by the American Railway Association. It is possible that the work of this division can be coordinated with the study being made by the railway companies themselves.

Considerable difficulty has been experienced in maintaining the roadway pavement outside the track area because of the vibrating and moving of the track construction. The edge of the pavement adjacent to the street railway track probably receives the heaviest traffic of the entire roadway. To compensate for the lower strength of the edge of the concrete pavement base, it has been found desirable, in Cleveland, to thicken the edge of the roadway slab adjacent to the track construction. It has also been found desirable to make a complete separation between the roadway pavement and the track construction, in order that the renewal and repairing of the track might not undermine the edge of the pavement or cause the paving surface to unravel. The present paving construction of the City of Cleveland now provides that a concrete beam shall be cast integral with the pavement base adjacent to the ends of the ties. The beam extends below the subgrade of the track pavement. The pavement surface is supported by a metal curb, which is built into the concrete base.

A number of materials have been used for pavement surfaces within the street railway tracks in Cleveland. The greater portion of the recent construction has been grout-filled granite blocks. Where the railway tracks are new and solid asphalt has proved satisfactory. Some concrete and brick paving has also been used.

Field Engineering and Inspection.— Finally, unless the field engineering and inspection follows a uniform interpretation of the standard specifications, the purpose of standards is only partially accomplished. Much good could be secured through the preparation of a standard manual of instructions and interpretations for the use of field engineers and inspectors.

The City of Cleveland has a manual of instructions for the use of its district engineers and inspectors. The city's contractors are assured of uniform engineering and inspection requirements whether their work is in one part of the city or another.

The form of the field organization in any city is largely determined by legal requirements and by precedent. Changes in the form of the organization can be made but slowly. It would probably be of value to city officials if they knew more about the form of field organizations in other cities. Such data could be collected and prepared in tabular form by your committee.

The use of full time, all-year-around inspectors, is very desirable from the standpoint of paving construction, but it brings the greater problem of how to pay and where to use this large group of men during the winter season. Perhaps some other city has solved this problem and your committee can learn of the solution.

Street Maintenance Committee Report

Committee Report Presented Jan. 15 at Cleveland Convention

By MAJOR C. E. MYERS
Chairman Committee on Maintenance; Director of Transit, Philadelphia, Pa.

IT is contemplated at this time to divide the maintenance committee into eight sub-committees, as follows:

1. Pavement Bases.
2. Concrete Surfaces.
3. Bituminous Surfaces.
4. All Types of Block Pavements.
5. Street Openings or Cuts.
6. Street Cleaning.
7. Resurfacing and Salvaging of Existing Pavements.
8. Unpaved Streets.

This first report of the general maintenance committee plans to touch briefly on the proposed work of each of the subcommittees. It does not contemplate making recommendations, but plans simply to state briefly the present status of the various kinds of work and the normal methods of procedure now in vogue in various cities. When it is realized that nearly twenty-five and a half million dollars is spent annually on maintenance alone, and largely by forces employed directly by the City, in some three hundred and twenty-six cities that have been tabulated, the importance of this subject may be grasped.

The work of a maintenance committee differs somewhat from a construction engineer's work. The maintenance end of the proposition does not advocate changes of types of paving, but must take what it finds, having inherited all kinds and all types of bases and surfaces. Its problem is to present a method of making repairs to its inheritance, whether or not the committee enjoys or believes in what it has inherited.

Pavement Bases. — Maintenance of pavement bases consists in most cities of making repairs to existing concrete bases. There are, of course, some old broken stone bases and some bituminous bases, but the larger quantity of the present street bases throughout the country appears to be concrete. Rigid type bases are found to exist varying from 5 in. of a 1:3:6 mixture up to extreme cases of 10 in. of a 1:2:4 mixture.

Repairs, generally, are made by maintenance forces directly in the employ of the municipality. Some cities have portable units, and make the repairs and mix the concrete on the street; other cities use pre-mixed concrete or wet batches for maintenance repairs. Some cities use an admixture in their concrete in order to close their openings as quickly as possible; others use a foreign fast-hardening cement and some an American fast-hardening cement; still others use a richer mixture for their repair work than was in the original base. There seems to be no uniformity in this field, each municipality being more or less of a law unto itself.

Concrete Surfaces.—As far as municipal work is concerned, with the exception of Seattle, Wash., and Washington, D. C., very few cities have adopted a concrete surface for city pavement work, owing, in general, to the difficulty in making repairs. The city of Washington, which probably has the largest yardage of concrete surface pavement to maintain, repairs entirely by city forces. They operate a concrete repair gang which is organized as a mobile unit and mix their concrete at or near the point of deposit. They maintain another gang exclusively for the pouring and sealing of cranks and joints. Throughout the country the general method is to make the repair of the same material and the same mixture as the original surface.

Bituminous Surfaces.—Repair work to bituminous surfaces, which, in the case of most cities, means sheet asphalt pavements, is taken care of almost universally in the larger cities by municipally-owned asphalt plants, and the material is laid by city employees. There are, of course, some exceptions to this rule. Some cities have annual contracts for asphalt repairs. The contractor is required to make the repairs not to exceed a total annual established yardage when and where desig-

nated by the engineer. Some cities also use small portable units for making their repairs.

Repairs to other types of bituminous surfaces are made in general with two types of material commonly known as "hot mix" or "cold mix." Under each of which sub-divisions there are a number of established methods.

Bituminous surface treatments are usual practice on the various macadam types of paving which are found in the outlying sections of the smaller cities, and sometimes very generally throughout the smaller cities. Again there are two general types of treatment—the hot and the cold application.

All Types of Block Pavements.—The general types of block pavements are wood block, asphalt block, vitrified block and stone (including granite) block.

Wood block has found but very little favor in city paving work in the past few years, and is rapidly being replaced with other types, quite frequently by the city maintenance forces. It is a very difficult pavement to maintain, as it is difficult to replace a small area because of the uneven wearing of the wood block.

Asphalt block has, in general, been unsuccessful, except in certain locations on wide streets where the traffic is well distributed. Like wood block, this material is very difficult to maintain because of the replacement. In many cases it is being replaced by another type of surfacing, usually by sheet asphalt. Asphalt block, however, is a convenient type to maintain in the small town that is not equipped with an asphalt plant.

Vitrified block at one time was used, especially in the smaller cities, almost exclusively, then fell into disfavor owing, generally, to inadequate bases. It is now rapidly returning to its proper field supported by an adequate foundation. It is a very easy type of pavement to maintain. Work can be handled with small gangs and small areas adequately patched. The older types are found with a sand filler; the more recent ones with a portland cement grout filler; and the very latest almost exclusively with a bituminous mastic filler.

Granite block has been and always will be the most nearly perfect surface for heavy traffic streets, especially on narrow width streets which are subject to tracking or rutting. Its expense, however, prevents quite frequently its use where conditions really warrant it. Its maintenance is very easy and simple, and replacements can be made in small areas, which is a distinct advantage. Like vitrified block, it is found in older cases on a sand foundation with a sand filler. The more modern pavements are either portland cement grout or bituminous mastic filler.

Street Openings or Cuts.—This is probably the most annoying of all maintenance problems. The practices in general use necessitate securing a permit to make the opening and replacement of the pavement in kind, i. e., the replacement to be made of the same material as the pavement removed. The method of making cuts and restoring them varies widely. Some cities require the company wishing to make the cut to take out a permit for each opening, to pay a fee to the city for the permit, and to make the replacement under city supervision. Other cities permit a company to have a blanket annual authority for making openings where they will, and to pay the city for the number of openings made in a calendar year, the company to replace the pavement. Still other cities permit a utility company to make the cut, charge them a fee for the permit and for the restoration, and then have the restoration made either by city forces or by an annual city contract. The committee believes that this subject should be one of those brought out at an open meeting discussion, and some effort made to secure uniform practice throughout the country.

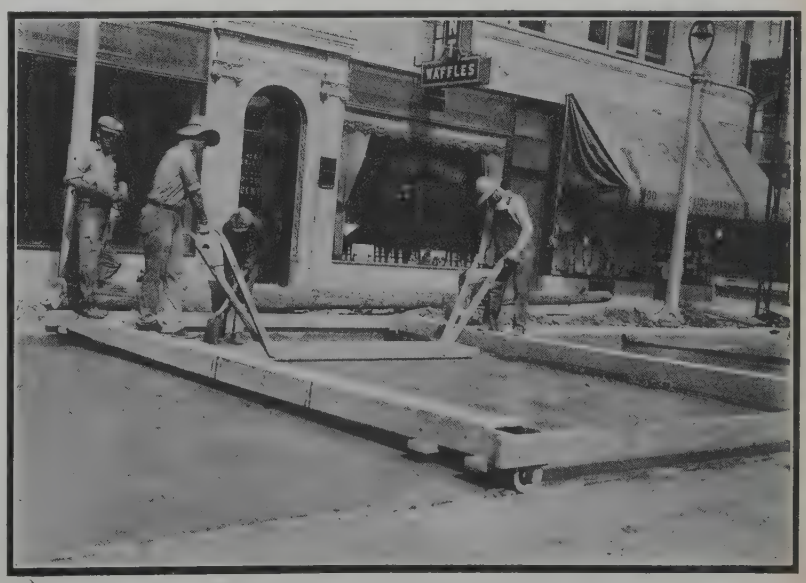
Street Cleaning.—The subject of street cleaning comes, from an organization standpoint, in some cities under the same head as highways; in others it is a separate bureau or department and has no connection with the highway organization. The street cleaning work sometimes consists of the flushing and cleaning of streets, the cleaning of inlets, the removal of garbage and waste, including ashes and sometimes one or more of these functions are done by other bureaus. Snow removal is handled, in some cities, by the street cleaning department, and in some by the highway department; other cities unite both departments and clean snow as an emergency measure.

For the normal cleaning of streets, the larger cities nearly all use power equipment for cleaning and flushing, supplemented in many cases by hand sweeping. Some cities use a vacuum or horse drawn brooms followed up by hand sweeping.

Snow cleaning and snow removal are handled in many ways by different cities. Some use snow blades mounted on trucks and simply plow the snow to the sides or center of the street; other cities use power loaders and remove the snow from certain streets; other cities do certain snow removal by hand. This is a very large subject, and it is hoped that this division will see fit to give it a great deal of study.

Resurfacing and Salvaging Existing Pavements.—This is a most interesting subject and one upon which much future discussion will be profitable. In many cases the resurfacing or salvaging is almost as expensive as complete repaving unless the base condition is completely ignored, and if this is done the salvaging is usually of little value. There are many cases where old block or brick pavements which are worn down can be crowned up to a true cross section, and by the use of surface heaters asphalt or other bituminous mixture may be applied to them. This same surface treating method may be used on portland cement concrete pavements, and many engineers believe that the ultimate end of the existing portland cement concrete roads is to cover them with a bituminous top.

Unpaved Streets.—The question of unpaved streets is one that varies in each locality. In many sections where there is a hard gravel natural soil, very little attention is paid to a street that has been graded and not paved until such time as buildings are erected on the abutting property. There are other cities, however, where street paving may have been omitted in one or two blocks on a street that is a very



important thoroughfare, and because of the assessment system in vogue the property owners on the abutting property, not having developed it, object to the paving charge. The result is that in most large cities there are certain sections of unpaved streets which are subject to an undue amount of traffic and must be kept in fair condition by the maintenance forces. This usually consists of taking care of the drainage as well as possible, and doing such crowning, including road dragging, as is practicable.

In many cases earth roads are given a dust laying oil treatment; in other cities they are sprinkled with water; while in still others, a bituminous application is made and chips are placed and rolled to give an inexpensive surface which is satisfactory for light traffic, at least in warm, dry weather.

In conclusion, it is believed that the eight sub-committees should be appointed and their work laid out for them at an early date, in order that at the next annual meeting a complete report may be made by each of the sub-committees. There seems to be throughout the country a wide difference of opinion as to the best methods to be employed in maintenance work, and it is believed an effort should be made to standardize the maintenance work of the various cities and that next year the maintenance committee should make recommendations along this line.

The work of sub-committee No. 5, Street Openings or Cuts, and of sub-committee No. 7, Resurfacing and Salvaging of Existing Pavements, covers, we think, two of the most important subjects in the highway field today.

Traffic on City Streets

Committee Report Presented Jan. 15 at Cleveland Convention

By M. O. ELDRIDGE
Chairman Committee on Traffic; Assistant Traffic Director, Washington, D. C.

THE City Officials' Division of the American Road Builders' Association, when organized in Washington on June 8, 1928, decided that one of its four major committees should deal with the question of traffic.

The object of the association in creating this committee was to collect and disseminate useful information, regarding traffic problems and to cooperate with other organizations in bringing about a reduction in the appalling loss of life, personal injury and property damage, and to facilitate the movement of traffic on the nation's streets and highways.

The traffic committee has not yet been organized, but a tentative schedule of assignments for committee work has been proposed as follows:

1—Causes of Accidents.
2—Rules of the Road.
3—Traffic Light Signals and Signs.
4—Parking Regulations.
5—Weights and Loads.
6—Traffic Zoning and Classification.
7—Drivers' Permits.
8—Safety Equipment.
9—Street Lighting.
10—Traffic Law Enforcement.

A letter was sent to each member of the city officials' division, who had indicated his willingness to serve on the traffic committee, requesting suggestions based on observations and experience on any one or all of the subjects selected for committee assignment. This was done in order that a preliminary report might be prepared and presented at the annual meeting of the association.

Sub-committee chairmen will be selected as soon as possible and assigned to the task of finding out how cities are going to take care of their future traffic problems and at the same time bring about a reduction in traffic fatalities and accidents.

Uniform Motor Vehicle Laws.—It is believed that the association should at this time approve and support the National Conference on Street and Highway Safety in its effort to bring about the enactment of uniform motor vehicle laws in the various states and uniform municipal ordinances in the various cities.

After two years' work by nearly a thousand representatives from every state in the Union, composed of traffic specialists, engineers and experts, and including official delegates appointed by the governors of forty-three states, a uniform motor vehicle code known as the "Hoover" Code was adopted in 1926.

This code, consisting of four separate acts, has been approved by the National Conference of Commissioners on Uniform State Laws and by the American Bar Association.

These proposed acts are—first, a motor vehicle registration act; second, a motor vehicle anti-theft act; third, an operators' and chauffeurs' license act; and, fourth, an act relating to the rules of the road and the operation of motor vehicles.

Municipal Traffic Ordinance.—Owing to the fact that there is less uniformity in traffic regulations of cities than in state laws the National Conference on Street and Highway Safety was requested to supplement its previous work by the preparation of a municipal traffic ordinance which might be used as a model for cities. Accordingly the Uniform Vehicle Code has been supplemented by a model Municipal Traffic Ordinance which was adopted by the Conference in August, 1928.

The Uniform Vehicle Code includes all the provisions ordinarily contained in the state laws, such as the basic regulations relating to speed limits, reckless driving, rules of the road, safety equipment of vehicles, licensing of drivers, suspension and revocation of operators' permits, registration of vehicles and anti-theft provisions.

The model ordinance sets up a uniform procedure in regard to the direction and control of city traffic, the erection of directional and warning signs, signals and markers, the parking of vehicles, and rules of the road for the protection and regulation of both pedestrian and vehicular traffic peculiar to city streets.

The proposals made in both of these codes are based on the wide experience and good judgment of the best known traffic specialists, engineers and experts in the United States.

This work was recently supplemented by a valuable contribution made by the American Engineering Council for the National Conference on Street and Highway Safety suggesting standard practices, relating to street traffic signs, signals, markings and traffic control devices.

The Traffic Committee will endeavor to place in the hands of those members who are interested in traffic, a copy of the three reports above referred to, and, it is urgently requested that they use their influence to bring the adoption of these model laws and regulations in their respective states and cities. This is particularly important just now at some forty-three legislatures meet early this year.

Need for Traffic Surveys.—No city can expect to make any real progress in reducing accidents or in solving its intricate traffic problems until it is in position to make careful and continuous engineering surveys as to the quantity and quality of its traffic, and until it is able to say to some degree of certainty where, when, how and why accidents occur.

To this end it is recommended that every city in which the traffic problem has become acute, and that means practically every large city, should establish an engineering traffic department or bureau. The municipal traffic ordinance contains in an appendix a suggested form of municipal enactment creating such a traffic engineering department.

Such department should be equipped with adequate funds and trained personnel for making traffic surveys, flow maps and spot maps and for tabulating and analyzing traffic accident reports. Such surveys and studies will indicate among other things:

1—Where traffic lights should be erected.

2—Which streets should be designated as through streets.

3—Where "Stop" signs should be placed.

4—Which streets should be well lighted at night.

5—Which streets should be designated for one-way traffic.

6—Where, in the interest of safety or for increasing street capacity parking should be restricted or eliminated.

7—Those streets which should be

paved, widened or zoned for special classes of traffic.

Improvement in Traffic Conditions at Washington, D. C.—Many of the proposals made by the National Conference of Street and Highway Safety have been adopted in Washington, D. C. Additional features of the code will be adopted as soon as Congress can be induced to so amend the traffic act. The proposals already adopted have resulted in bringing about an improvement in traffic conditions.

This improvement has been brought about by—

1—Electric traffic signal lights along the lines suggested by the American Engineering Council.

2—The establishment of a system of through streets and the prohibition of parking on the flow side of such streets during the rush hour.

3—By the installation of a practical and effective program providing for the licensing of all motor vehicle drivers after an examination on the regulations and a driver's test.

4—By the prompt cancellation or suspension of the drivers' permits of those who have committed serious traffic offenses or who are found to be mentally or physically incapable of safely operating an automobile.

5—By a vigorous and impartial enforcement of the traffic laws and regulations.

That the traffic reforms adopted in the nation's capital are accomplishing the desired results is shown by the fact that fewer persons in each 100,000 of population have lost their lives in traffic accidents in Washington during the past three years than in any other metropolitan city in the United States.

In all fairness it must be said, however, that during the past year the traffic fatality record of one large city, namely, Baltimore, has shown an improvement over that of Washington.

In conclusion let me emphasize the thought previously expressed in this report and that is, that no city can expect to make any material improvement in its traffic accident problem until it is able to say with some degree of certainty where accidents occur, how they occur and why they occur.

City officials should always remember that accidents do not happen—they are caused. It is, therefore, recommended that this thought be adopted as the slogan of this committee—

"ACCIDENTS DO NOT HAPPEN—THEY ARE CAUSED."

Typhoid in the United States.—According to Public Health Reports for Sept. 7, 1928, the number of typhoid fever cases was unusually small during the past summer. The total for the eight weeks from July 1 to Aug. 25 was 5,821 as compared with 7,600 for the corresponding weeks in 1927 and 8,527 in 1926.

Bibliography on Regional Government

A Bibliography on Regional Government has recently been prepared under the auspices of the School of Applied Social Sciences and the Political Science Department of Western Reserve University.

Considerable time has been spent in making the Bibliography as complete and specific as possible. It contains 58 pages and references to about 645 specific sources, together with an outline and index with page references.

Part I includes articles and books of a general nature, while Part II refers to the various forms such as Special Districts, Annexations, City-County Consolidation, Borough Government and Metropolitan Areas. Parts III and IV contain references to County and Township Government. Part V includes articles on the Legal Aspects of this problem. Part VI deals with current bibliography. There are references to English and German articles as well as American.

This Bibliography has been carefully mimeographed and bound ready for distribution. Copies may be purchased at 50 ct. each on application to Roland Mulhauser, Library of Research in the Social Sciences, Western Reserve University.

Westchester County, N. Y., to Spend $1,545,000 for Park Maintenance.—The Westchester County Park Committee White Plains, N. Y., has notified the County Board of Supervisors that its 1929 budget would call for about $1,545,000 to operate and maintain the park system, including the general offices at Bronxville and "Playland," the newly opened amusement park operated by the commission at Rye Beach. This is an increase over the 1928 appropriation of approximately $343,000, but is due to more park facilities.

Indiana Water Works Men Meet in February.—The next meeting of the Indiana Section of the American Water Works Association will be held Feb. 27-28 at Indianapolis, Ind. C. K. Calvert, 1902 North New Jersey St., Indianapolis, Ind., is secretary.

Water Wasted by Various Size Orifices

The 40th annual report (1927) of the Board of Water Commissioners of Dover, N. H., contains the following interesting table showing the amount of water wasted through different sized openings. The table is calculated for a rate of 23 ct. per 100 cu. ft:

Cost of Water Wasted by Various Sized Openings

Diameter of orifice in fraction of an inch	POUNDS PRESSURE PER SQUARE IN. AT ORIFICE 50 lb. Cubic feet discharged per day	50 lb. Value at 23c per 100 cu. ft.	65 lb. Cubic feet discharged per day	65 lb. Value at 23c per 100 cu. ft.	85 lb. Cubic feet discharged per day	85 lb. Value at 23c per 100 cu. ft.
1-16	153	$ .35	167	$ .38	198	$ .45
1-8	613	1.31	667	1.53	760	1.74
1-4	2,467	5.77	2,667	6.13	3,066	7.05
3-4	21,333	49.07	24,400	56.12	28,000	64.40
1	39,466	90.87	42,667	98.12	49,066	112.85
1-2	9,867	22.79	10,667	24.53	12,266	28.21

The Troubles of the City Clerk

The following quip comes to us on the back of the business card of Mr. Arthur W. Smith, City Clerk, Amsterdam, N. Y.:

Pity the City Clerk

If the City Clerk writes a letter, it is too long.
If he sends a postal, it's too short.
If he sends out a notice, he's a spendthrift.
If he doesn't send out a notice, he's lazy.
If he attends a committee meeting, he is butting in.
If he stays away, he is a shirker.
If he sends out bills, he is insulting.
If he fails to collect bills, he is slipping.
If he asks for advice, he is incompetent; if he does not he is bull-headed.
If he writes his reports complete, they are too long, and if he condenses them, they are incomplete.
If he talks on a subject, he is trying to run things, and if he remains quiet, he has lost interest in the city.

Ashes to ashes,
Dust to dust,
If the others won't do it,
The City Clerk must.

Sewer Cleaning at Chicago.—During 1927 the Bureau of Sewers of Chicago cleaned 9,685,000 ft. of sewers by flushing, and 892,200 ft. by scraping. In addition 28,860 catch basins were cleaned by machine and 48,665 basins by hand. The cost of the work, according to the annual report of Geo. E. McGrath, Superintendent of Sewers, was as follows:

Flushing, per 1,000 lin. ft.	$ 7.58
Scraping, per 100 lin. ft.	13.67
Catch basin cleaning by hand	3.93
Catch basin cleaning by machine	2.63

Rocky Mountain Water Works to Meet.—The 3rd annual meeting of the Rocky Mountain Section of the American Water Works Association will be held Feb. 14 and 15 at Denver, Colo. D. E. Kepner, Division of Sanitary Engineering, State Board of Health, Denver, Colo., is secretary.

Eight Million Dollars Voted for Airports.—Bond issues for the purpose of purchase or development of municipal airports were voted at the November election by Detroit, Columbus, St. Paul, Seattle, Hartford, Chattanooga and five other cities aggregating almost $8,000,000. Detroit alone voted a bond issue of $5,000,000.

Annual Convention of Montana Water Works Men.—The 4th annual convention of the Montana Section of the American Water Works Association will be held April 4, 5 and 6 at Great Falls, Mont. H. B. Foote, Division of Water and Sewage, State Board of Health, Helena, Mont., is secretary.

The Water Filtration Plant of the City of Montreal, Quebec

Construction and Operation Features of New Extension

By F. E. FIELD and J. H. HARRINGTON
Filtration Engineer, Montreal Water Board; and Chemist Montreal Filtration Works

THE plant as originally designed by Messrs. Hering and Fuller and constructed under their supervision included the following:

Low lift pumping station, capacity 150 m.g.d. (Imp.).

Sixteen pre-filters, nominal combined capacity, 50 m.g.d. (Imp.), unit sand area, 1,200 sq. ft.

Sixteen final filters, nominal combined capacity, 50 m.g.d. (Imp.), unit sand area, ⅝ acre.

Filtered water basin No. 1, capacity 6¼ m.g. (Imp.); and such conduits, gate houses and equipment to make the installation complete and ready for operation.

Construction work was started in 1911, but on account of numerous delays was not completed and placed in service until April, 1918.

The cost of this plant complete, exclusive of land, was $1,408,300, or $28,000 per m.g.d. (Imp.) at normal rating.

The original scheme was to have the pre-filters and final filters operated together as one plant, i. e., double filtration, without the use of coagulant, but the conduits and gatehouses were designed to permit of the pre-filters and final filters being operated as separate plants or as partially combined plants.

This foresight on the part of the designers of the original plant has been amply justified.

In 1910 the average daily output of the municipal water works plant was 38 m.g. and the filter plant was designed for 50 m.g.d. nominal capacity which would permit of a 30 per cent increased output.

In 1918, the first year of operation, the required output of filtered water was 60 m.g.d. (Imp.) or 20 per cent above the designed nominal capacity of the plant.

The demands for filtered water increased rapidly in succeeding years and last year, i. e., 1927, the daily output was 85 m.g. (Imp.) or 70 per cent in excess of the designed nominal capacity of the plant.

During July, 1928, the average daily output was 92 m.g. and the maximum day's output was 97.6 m.g. or 94 per cent in excess of the designed nominal capacity of the plant.

Notwithstanding this excessive overload on the filters, the plant has run continuously and has at all times delivered to the citizens of Montreal a water satisfactory in all respects.

Filter Extension.—The need for additional filters has been recognized for several years, but construction was delayed until adequate pumping capacity was provided by the completion of the new low level pumping station.

This contains six 30 m.g.d. pumping units with provision for extending the building to house six additional pumps of the same capacity.

To provide ample storage of filtered water, filtered water basin No. 2 was constructed between filtered water basin No. 1 and the new low level pumping station. This basin, having a capacity of 20 m.g. (Imp.), was constructed at a cost of $624,400.

During the construction of the new low level pumping station and filtered water basin No. 2, several schemes for filter extension were studied and estimates of cost compared. The satisfactory operation of the existing pre-filters and the comparatively low cost of constructing 32 additional filters, similar in size, arrangement and general design, above the roof of filtered water basin No. 1 resulted in this plan being adopted.

These 32 additional filters will have a combined nominal capacity of 100 m.g.d. (Imp.) which added to the original plant will make the total nominal capacity of the plant 150 m.g.d. (Imp.), which equals the nominal capacity of the new low level pumping station.

In all probability the original 16 pre-filters and 16 final filters will be operated as a combined plant and the 32 new filters will be operated as rapid sand filters and discharge independently into filtered water basin No. 2.

The cost of this work now nearing completion may be subdivided as follows:

Earthwork, filters, buildings, etc.	$ 360,000
C. I. piping, gate valves and sluice gates	213,958
Air piping and small piping	17,880
Filter rate controllers	40,000
Filter operating tables and gages	66,641
Filter strainer and air system	67,867
Wash water gutters	17,203
Filter sand and gravel	69,038
Gages, telephone system and signal system	12,129
Chlorination building and equipment	24,000
Park lighting system	14,303
Fence and gateways	46,000
Greenhouse, trees and shrubs	11,500
Miscellaneous work and equipment	48,621
Total	$1,009,140

This makes the cost of the filter extension $10,000 per m.g.d. (Imp.) nominal designed output.

The total cost of the filtration works is therefore $2,417,440, which on the nominal designed capacity, 150 m.g.d. (Imp.), makes the construction cost $16,116 per m.g.d.

Filter Strainer and Air System.—The strainer system in the original pre-filters and the new rapid sand filters are identical and furnished by the Roberts Filter Mfg. Co. It consists of C. I. manifolds and 1¾-in. C. I. pipe laterals on 6-in. center, approximately 6 ft. in length with two ⅛ bronze orifices for each 6 in. of lateral.

This system is for both air and water wash. The air is supplied from a rotary Root's blower having a capacity of 5,000 cu. ft. of free air per minute against a pressure of 5 lb. per square inch, which gives approximately 4 cu. ft. of air per minute for each square foot of sand surface in a filter.

The wash water is supplied from a wash water tank and is delivered at the rate of approximately 8½ Imp. gallons per minute for each square foot of sand surface.

Filter Sand and Gravel.—The filter gravel in the original pre-filters and in the new filters is deposited in four layers of specified screened sizes to a total combined depth of 15 in.

The filter sand is 30 in. in depth. In the original pre-filters this sand had an effective size of between 0.50 m.m. and 0.60 m.m. and a uniformity coefficient of about 1.65.

In the new filters the effective size of the sand varies from 0.40 m.m. and 0.50 m.m. and the uniformity coefficient is about 1.68.

In the original final filters, there is 12 in. of graded gravel placed in four layers and 27 in. of sand having an effective size of from 0.25 m.m. to 0.35 m.m.

Rate Controllers.—Each of the original pre-filters and final filters was equipped with controllers of the Earl type with a master controller to regulate the entire system. These controllers have given satisfaction in all respects.

The new filters will be equipped with controllers furnished by the Builders' Iron Foundry and will work in conjunction with their new pendulum diaphragm units for loss of head and rate of flow below and their new loss of head and rate of flow gauges on the operating tables in the filter galleries.

These controllers are also provided with master control.

Average Runs, Final Filters, 1927

Month	No. of Washes	Average Runs Days	Hours
January	22	22	8
February	15	29	12
March	30	16	4
April	42	11	4
May	46	10	9
June	41	11	12
July	36	13	12
August	38	12	18
September	23	20	15
October	24	20	8
November	23	20	13
December	36	13	7
Total	376	....	....
Average	31	16	22

Operating Tables. — All operating tables in the galleries are of the piano type and constructed of gray marble, which makes an attractive contrast with the red tile floor of the gallery.

Clock and Signal System.—The wash water pumps, wash water tank and piping system do not have sufficient capacity to permit of more than one filter to be washed at the same time.

This makes it necessary for the filter operator in one gallery to be kept informed, not only as to the supply of the water available in the wash water tank, but also as to whether or not filter washing is in progress in either of the other two galleries.

It is expected that the clock and signal system will systematize the filter washing and prevent interference in the work of filter operators in the three filter galleries.

This system includes the master clock and signal lights in the superintendent's office, and secondary clocks and signal lights in each of the three galleries, the entire system being electrically operated.

The system is so arranged that when the influent valve to any filter is closed by operating a handle on the operating table, a light will automatically show at the master and secondary clocks and continue to show until the influent valve is again opened; thus completing the cycle of a filter wash.

There is also a switch on each operating table whereby the automatic lighting of the signal from that particular table is cut out, if, for any reason, the influent valve is operated for any purpose except the washing of the filter.

The lights to indicate when filters are being washed are three in number and show red for filters in gallery No. 1, yellow for filters in gallery No. 2, and green for filters in gallery No. 3.

The master clock in the superintendent's office is of the wall type with the three signal lights incorporated in the bottom of the case.

The secondary clocks, suspended from the ceiling in the center of each operating gallery, are double-faced with illuminated dials so as to be easily read from the far ends of the gallery.

The three signal lights are incorporated in the bottom of the bronze case.

The depth of water in the wash water tank is also indicated on the clock in the following manner:

Immediately concentric with the outside of the dial is a ring which is automatically illuminated to show the depth of water in the tank. The total depth of the wash water tank is 12 ft., which corresponds to the hour figures on the clock dial. Therefore, by reading clockwise, the hour figure at the end of the band of illumination will indicate the depth of the water in the tank.

Inter-Phone System.—To still further assist the operators in the performance of their work, an inter-communicating telephone system will be installed.

Telephone sets will be installed in the superintendent's office, clerk's office, in each of the three filter operator's booths, at the electrical operator's desk in the pumping station, in the chlorination building and at such other places as are deemed necessary.

In galleries Nos. 2 and 3 the discharge from each filter enters a gallery effluent conduit which extends the entire length of the pipe gallery and passes through a gatehouse into a conduit which discharges into the filtered water basin.

The water level in the filtered water basin is several feet lower than the invert of this gallery effluent conduit. With water in the filtered water basin at a low level and with a low rate of discharge in the gallery effluent conduit, the discharge ends of the filter effluent pipes would not be submerged, thus allowing entrance of air to the bottom of the filter beds when the water level in the filtered water basin raised or the discharge through the gallery effluent conduit was increased.

To prevent any possibility of air entering the filters in this manner, a water level controller will be installed in the gatehouse at the end of each pipe gallery.

A float operating a pilot valve connected to the piping of the hydraulic cylinder of a 60-in. by 60-in. sluice gate, controlling the discharge of the gallery effluent conduit, will automatically maintain the water level in the gallery effluent conduit in such manner as to keep the filter effluent pipes submerged, and not decrease the available loss of head in the filters.

Chlorination Building and Equipment. —This building is above the chamber through which all filtered water passes on its way to filtered water basin No. 2 and the new low level pumping station.

Maximum and Minimum Yields, Final Filters, 1927

Month	Maximum M.G.D.	Minimum M.G.D.	Average M.G.D.
January	82.32	62.47	70.87
February	87.45	75.75	81.70
March	84.39	76.94	80.82
April	81.20	23.19	66.48
May	61.74	22.50	40.73
June	71.06	58.72	65.25
July	71.77	56.87	65.09
August	74.74	63.71	71.41
September	76.17	67.59	72.96
October	74.91	62.03	69.36
November	78.59	62.41	66.58
December	77.66	64.41	70.90
Average	76.83	58.05	68.51
Filter Rate m.g.a.d.	4.80 12.81	3.63 9.68	4.28 11.42

Average Runs, Pre-Filters, 1927

Month	No. of Washes	Average Runs Days
January	83	143
February	77	139
March	149	80
April	847	13
May	421	28
June	239	32
July	283	42
August	197	60
September	89	129
October	90	132
November	134	86
December	140	80
Total	2,758	964
Average	230	80

This chamber is provided with baffle walls to obtain a thorough mixing of the chlorine dose with the filtered water.

The central portion of the floor of the chlorination building is depressed to permit of the installation of weighing scales with platforms level with the operating floor.

The platforms of these weighing scales are of such size as to allow 12 cylinders of liquid chlorine to be placed thereon.

Each cylinder is connected by piping to a manifold which leads to the chlorination control table. This table is of grey marble, of piano type, similar in design to the filter operating tables.

This table houses "Duriron" ejectors and distributors. The suction produced by water under pressure passing through these ejectors draws the chlorine from the cylinders on the platform scales and discharges it into the baffled current of filtered water in the chamber below.

On the top of the operating table are located the necessary gauges and valve controls and also apparatus for testing the water after chlorination.

The building is of sufficient size to permit of the entrance of a truck loaded with cylinders or drums of liquid chlorine, and an overhead travelling crane facilitates the handling of these liquid chlorine containers.

Park Features.—The filtration works and low level pumping station are located on an 80-acre tract of ground between the water supply aqueduct and the city of Verdun. An attractive iron fence, 5,000 ft. in length, marks the boundary line on three sides of the property. There are eight gate entrances to afford easy access to all parts of the works.

The north end of the property has already been made into an attractive park by the construction of driveways and paths, grading and seeding and the planting of trees and shrubs.

Two lagoons, each 50 ft. by 150 ft., with water sprays and several flower beds, greatly improve the appearance of the new low level pumping station.

This year we are grading, seeding and planting about eight more acres; and at this rate of progress it will only require a few years to develop the whole

property. Largely due to the interest shown by the filtration staff during the last few years in the growing of plants and flowers, a small greenhouse, 18 ft. by 37 ft., is now under contract. It is so located that access is available from a covered passage from filter gallery No. 1 and will permit the growing of plants for the outside flower beds and for decorating the filter buildings and pumping station.

Raw Water Supply.—The two river intakes from which the filtration works obtains its supply of raw water are located about 20 miles below the confluents of the St. Lawrence and Ottawa Rivers. The intake normally in use is about 1,200 ft. from shore; the other or shore intake is protected by ice cover in winter and can be used when frazil ice causes trouble in obtaining the required volume from the outer intake.

Both intakes supply varying mixtures of the St. Lawrence and Ottawa River waters, depending upon seasonable and local weather conditions.

The shore water is largely Ottawa River water and carries all the domestic pollution of 12 small towns, except that which is diverted into the Lachine Canal.

From these intakes, the raw water is conveyed by the Montreal aqueduct canal and its lateral conduit, a distance of about five miles to the filtration works. The lower three miles of the Montreal aqueduct now serves as a sedimentation basin with about 30 hours storage at a 100 m.g.d. rate of flow which quite materially reduces the number of bacteria of sewage origin in the raw water before it reaches the filtration works.

As regards physical characteristics, the outside water is more desirable than than from the shore. Turbidity is not a serious problem, as neither river carries much suspended matter except for short periods in the spring and sometimes in the fall.

The normal color of the St. Lawrence River (outside water) is from 10 to 15 p.p.m., while the color in the shore water may reach a maximum of 8 p.p.m.

The operator therefore endeavors to have the intakes controlled in such manner as to reduce as far as possible the entrance of shore water.

Rapid and Slow Sand Filters, 1927.

Maximum and Minimum Yields, Pre-Filters, 1927

Month	Maximum M.G.D.	Minimum M.G.D.	Average M.G.D.
January	56.88	53.78	55.85
February	56.00	55.69	55.84
March	56.00	55.24	56.79
April	55.64	51.19	55.23
May	55.78	51.03	55.43
June	55.80	54.10	55.58
July	56.00	51.28	55.47
August	55.83	54.80	55.64
September	56.00	54.17	55.76
October	55.85	54.31	55.75
November	55.85	55.69	55.81
December	56.00	53.08	55.70
Average	55.90	53.86	55.65
Filter	3.49	3.37	3.48
Rate m.g.a.d.	139.75	134.65	139.13

Cost of Operation

Distribution	Operation Wages	Operation Supplies	Maintenance and Repairs Wages	Maintenance and Repairs Supplies	Total	Cost M.G.	Per Cent
Supervision	$ 3,213.00	$.....	$ 567.00	$.....	$ 3,700.00	$0.12	5.86
Pumping station	10,866.60	313.57	361.41	297.03	11,838.61	.38	18.36
Pre-filters	4,575.39	272.06	698.77	63.47	5,609.69	.18	8.70
Final filters	3,474.35	366.50	1,238.76	1,540.26	6,619.87	.21	10.27
Laboratory	3,085.68	1,489.90	255.98	41.50	4,873.00	.16	7.56
Sterilization	2,417.12	12,534.75	462.45	245.03	15,659.35	.50	24.29
Electric current	.....	14,240.00	.....	.....	14,240.00	.46	22.08
Building and ground	.....	.....	1,737.91	120.58	1,858.49	.06	2.88
Total	$27,632.14	$29,216.78	$5,322.22	$2,307.87	$64,479.01	$2.07	100.00

Total filtrate in 1927, 31,125.12 m.g.

—The rapid sand filters show an average bacterial removal of 73 per cent when operated at an average rate of 139 m.g.a.d. without use of coagulant.

The final filters, with a mixture of raw and pre-filtered water in the approximate ratio of 3 to 4 as applied water, show an average bacterial removal of 85 per cent when operated at an average rate of 11.5 m.g.a.d.

The overall bacterial removal by filtration (i. e., before chlorination) was 87.5 per cent.

Chlorination.—The slow sand filter effluent and that part of the rapid sand filter effluent diverted to the filtered water basin to make up the total daily demand on the plant have been chlorinated during the past year at their mixing point in gate house No. 2.

A small sample pump returns chlorinated water from a point in the filtered water basin representing an absorption period of about two minutes. Hourly samples at this point show the residual chlorine content under these conditions to be very uniform.

Occasionally sixteen tests are made in rapid succession. These tests are always within .03 to .05 p.p.m. variation from the standard required and show that the mixture of chlorine is instantaneous and uniform, a condition essential to otbain high efficiency.

The dose is varied to obtain 0.2 to 0.3 p.p.m. residual chlorine after two minutes absorption.

The percentage of Ottawa River water at the intake varies seasonally and may vary daily through the agency of high winds.

The dose increased or decreased as the percentage of Ottawa River water is greater or less, "Straight" Ottawa River water requires seven times as much chlorine as that from the St. Lawrence to insure practical sterility.

The overall removal of bacteria after chlorination for the past year was 99.9 per cent.

Operation Records.—The following tables show the details of operation during the year 1927:

General Characteristics of Water from Plant, Year 1927

Alkalinity Ca Cos	82	60	71
Turbidity, less than	2	2	2
Color	30	7	22
Incrusting solids	12.6	9.3	11.0
Total solids	129.	109.	118.
Bacteria per c.c.	12.	3.	6.
B. coli per 10 c.c., less than	1.	1.	1.

Acknowledgment.—The above is an abstract of a paper presented at the Montreal Convention of the New England Water Works Association.

Philadelphia Engineers Club to Discuss Concrete

A meeting when the subject of concrete construction—roads and structures—will be under discussion will be held at the Engineers Club of Philadelphia, 1317 Spruce St., Philadelphia, on Feb. 19, 1929. There will be two sessions, with dinner intervening. The first session will be from 2:00 to 5:00 p. m. Dinner at 6:00 o'clock. The evening session, 7:30 to 10:30 p. m.

Papers and discussion will specialize on "High Strength, High Early Strength, and Waterproof Concrete, both from a Theoretical and Practical Standpoint in Design and Construction," will be given.

A number of engineers who are prominently identified with this type of construction will read papers and take part in the discussion. Men from New York, Philadelphia, Washington, Chicago and other cities will be present.

Engineers and contractors who are interested in this subject are invited to attend.

The committee in charge is W. H. Connell, Henry Delaplaine, F. O. Dufour, W. E. McComas, P. M. Taylor, T. P. Watson.

Improvements During Ten Years Operation

	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Unfiltered but chlorinated raw water added to filtered effluent to make up total city demand, m.g.d.	20.3	18.5	21.8	19.5	19.8	10.6	13.4	7.7	0.8	0.0
Raw water added to final filter influent to allow of increased output from final filters, m.g.d.	0.0	0.0	0.0	0.0	0.0	4.8	3.2	11.3	19.6	29.6
Total filtered, m.g.d.	42.7	50.8	51.2	50.0	56.2	59.8	58.2	66.3	75.6	85.3
Total consumption, m.g.d.	63.0	64.3	73.0	69.5	65.0	70.4	71.6	73.8	76.4	85.3
Total cost purification including chlorination	.....	.....	4.70	4.71	4.62	3.52	3.78	3.23	2.96	2.07
(Imp.) m.g.d.	.....	.....	3.76	3.77	3.70	2.82	3.00	2.58	2.37	1.66
(U.S.) m.g.d.										

A Few Details of Sewage Treatment in Germany and England

Some Comments Based on Recent Personal Observation

By SAMUEL A. GREELEY
Of Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers, Chicago, Ill.

IN England and Germany, much as in the United States, there is an increasing public demand for cleaner streams and for the return of fish life where this has been driven out. This has resulted in Englnad in the recent creation by Parliament of the River's Pollution Research Board with a notable personnel; and in both countries in an increasing activity in sewage treatment work. Munich is building a very large installation of fish ponds for the final purification of a settling tank effluent (cost 5 million marks or $1,250,000); Stuttgart is enlarging its sprinkling filters; Sheffield is doubling the size of its aeration plant; at Birmingham a project has been approved for bringing the capacity of the pre-aeration works up to 24 U. S. M. G. D. and of the sludge gas engine installation from 150 to 600 H. P.; much new construction may be seen in the Ruhr valley, etc. Some of the more pertinent details are briefly described below—based on recent personal observation.

The sewage of most European cities is, of course, low in quantity and high in concentration as compared with sewage in the United States. But, in addition to this proportionate concentration, the strength of the sewage is increased in many instances by the industrial wastes, which have a marked effect because of the relatively small volume of human sewage. Thus at Bury, the sewage is at times acid and at many cities the characteristics of the sewage change sharply from hour to hour.

Preliminary Treatment.—A special point of interest are the oil removal tanks in the Ruhr valley. It is Imhoff's view that perhaps half the oily matters are attached to particles of suspended matter and are not removed by quiescent flotation. Therefore the sewage is agitated or scrubbed with air to break the oil loose from the suspended matter. Quiescent side-pockets trap the oily matters. The quantity of air is indicated at one-tenth the volume of sewage 0.0133 cu. ft. per gallon and the aeration period at three to five minutes.

In many of the English plants, settling periods of eight hours or more are used. Thus the new settling tanks at Reading, to work ahead of aeration tanks, will have a displacement period of about ten hours. These relatively large settling tanks serve as balancing tanks tending to make both the rate of flow and character of sewage more uniform. Further, experience seems to indicate a coagulating process in the settling tanks which tends to wash out some colloidal matter and so better prepares the sewage for further treatment.

In the Ruhr valley, separate sludge digestion tanks are being used in conjunction with deep 2-story tanks having relatively small sludge compartments. It is held that the sludge is concentrated in the 2-story tank, thus requiring much less volume in the separate tank; and that the temperature and reaction of digestion can be better controlled in the separate tank. The combination of the two is thus favorable as to both economy and efficiency.

Sludge Digestion.—The digestion of sludge in separate tanks appears to be gaining in favor somewhat slowly, but along sound lines. The oldest separate digestion works visited were at Birmingham, first started in 1909; the most recent were in the Ruhr valley. Most of the digestion tanks were characterized by having relatively flat bottoms as compared with practice in the United States. Bottom slopes as flat as 1 in 100 were used. The sludge is withdrawn by gravity or by pumping, but sludge pumps are generally provided for circulating sludge and for mixing ripe and fresh sludge. In fact, a sludge pump appeared to be required for good operation and the intimate mixture of ripe and fresh sludge was often regarded as an essential routine procedure and was accomplished by passing them together through the pump. The proportions of the two sludges in the mixture varied of course, even at the same plant, but approximated one part of ripe sludge to from 3 to 5 parts of fresh sludge.

It seems to be accepted that the best way to heat the sludge is by pumping hot water into it. This was done in the Ruhr valley, at Stuttgart, and occasionally, in very cold weather at Birmingham. The temperature of the hot water supply at Stuttgart was 150° F. and at Essen Relinghousen upward of 185° F. The water was heated by burning the sludge gases and was relatively small in quantity, the indication being that the radiation losses were not considerable.

A variety of covers were in use. The floating sectional concrete covers at Birmingham made a very favorable impression. As Essen Relinghousen the digestion tank has a fixed concrete cover with a circular opening about the circumference which laps over a triangular corbel built out of the side wall, much like the traps in a 2-story tank. The fixed concrete cover was submerged about 2 ft. with scum, but there was little or no escape of gas. At Stuttgart a flat arched slab was used. However, there appeared to be little fear of odors from open digestion tanks which were being adopted for some new installations.

Sludges from primary settling tanks, final settling tanks and excess activated sludge were all returned to the digestion tank, but the weight of practice favored the delivery of the final and wetter sludges to the incoming sewage, to be settled out and recovered with the primary tank sludge and then discharged into the digestion tank. Their moisture content was thus reduced and Imhoff suggests a capacity of 2 cu. ft. per capita for digesting both primary and final sludge, one-third being in the 2-story tanks.

Sludge Gas.—Gas from the digesting sludge is being caught, measured, and used. In some cases the gas is used only for heating the water which is pumped into the sludge tank as at Stuttgart and Essen Relinghouse. But at Iserlohn in the Ruhr valley all the power required for the operation of the sewage plant is made by the operation of a small gas engine working directly on sludge gas. At Birmingham a 150 H. P. gas engine has been working directly on sludge gas for the last nine months and an additional 450 H. P. unit is about to be installed. The gas is not cleaned in any way and there is no gas holder, the only storage being in the gas catchers floating on the sludge. It was stated that there had been no evidence of pitting during nine months of almost continuous service. It is estimated that the sewage of Birmingham (close to one million people) will yield enough sludge gas to produce 1,000 brake horse power.

Extensive detailed information relating gas quantities to weights of organic matter, temperatures of digestion, and the like cannot be acquired in a short visit. The following round figures, however, were given for sludge from primary settling tanks:

Place	Gas in Cubic feet per capita
Ruhr Valley	0.37—0.28
Stuttgart	0.32
Munich	0.47
Birmingham	0.41

In the new (1928) edition of his hand book, Imhoff gives an excellent typical computation of gas quantity based on organic matter under digestion and the conditions of digestion. Thus (page 67) on the basis of 15 grams per capita per 24 hours of organic matter in the settling solids, the actual quantity of gas is 0.37 cu. ft. (10.5 litre) per capita per 24 hours, of which Imhoff estimates 0.28 cu. ft. may be developed in routine operation.

Biological Treatment.—Aeration by mechanical agitation has been in operation in England for three to four years and its use is continuing. The paddle wheels at Sheffield have been treating 9.6 to 12. U. S. M. G. D. of settled effluent for nearly four years with, apparently, marked success and the installation is now being doubled in size. The plant makes a most favorable impression. Simplex aerators have been in operation at Bury for over three years and are being installed in several other places. Plants using air are also being built and there seems to be no preponderance of opinion. Perhaps, on the whole, more aeration plants are being built at the present time with mechanical agitation than with air and in the Ruhr valley a combination of air and paddles is successfully used in the same tank.

Sprinkling filters are still in use for two-thirds of the sewage at Bury and new units have been added at Birmingham within the last year. There seems to be no disposition to discard them in favor of the activated sludge method and many can be seen in operation in England. In a general way, comparative total annual costs of sprinkling filter and activated sludge plants were not far different from the trend of such costs in the United States, the total annual costs being about equal when power costs around 1 ct. per kwh.

The partial aeration of the sewage between the settling tanks and sprinkling filters at Minworth has been successful and the capacity is being extended from 9.0 to 24.0 U. S. million gallons per 24 hours. The sewage is agitated in contact with activated sludge by air and paddles for one hour in channels having a cross-section of 18 sq. ft. and a flow length of 3,300 ft., and then settled in upward flow settling tanks. The sludge is reaerated with air for 10 hours at the rate of somewhat over 1.5 cu. ft. per gallon of sludge. This pre-aeration has permitted an increase of the quantity of sewage applied to the filters of about three times.

There is no indication of projects to process activated sludge to a fertilizer base in England or in Germany.

I was told in England that the cost of a complete treatment plant was not far from 2 pounds ($10) per capita of rated capacity.

The new filters at Minworth (Birmingham) have been equipped with travelling disturbutors on rectangular beds. I gathered that operating experience with travelling and fixed spray distributors indicated that a somewhat greater load could be handled by the filters with the travelling distribution. It is interesting to see sprinkling filters at Birmingham which have been in continuous operation for 25 years without any marked deterioration of the filtering material. Broken granite, coke breeze and broken gravel are used. Some of the filters have a top layer of fine gravel (about ¼-inch size), some 12 in. thick.

Final Sedimentation.—I found more common use of deep upward flow tanks for final sedimentation than of any other sewage treatment device. Such tanks are generally built square or round, perhaps 30 ft. in diameter and 25 to 30 ft. deep. The aeration tank or filter effluent is discharged at the bottom of a relatively large vertical

Sludge Drying Beds and Miscellaneous Views of Various Features of English Sewage Disposal Works

(1) Sludge-Drying Beds at Bath Sewage Disposal Works. (2) Air-Dried Sludge Ready for Removal from Bed at Bath Sewage Disposal Works. (3) Mechanical Removal of Coarse Detritus at Birmingham Sewage Disposal Works. (4) Cleaning Detritus Tank at Birmingham Sewage Disposal Works. (5) Effluent Weirs at Manchester Activated Sludge Treatment Plant. (6) Traveling Distributor at Leeds Sewage Disposal Works. (7) Storm Water Overflow at Leeds Sewage Disposal Works. (8) Experimental Activated Sludge Sewage Treatment Unit at Kidderminster. (9) Kidderminster Sewage Form, Showing Irrigation of Sugar Beet Crop.

flume and generally not over 10 to 12 ft. below the surface. Weirs, built very accurately, are provided on all sides for taking off the clear liquor. The settling periods in these tanks were not generally over two hours, but the upward velocity computed on a displacement basis was the more usual index of size, the following figures being typical:

Character of sewage	Limiting Upward Velocity in ft. per hour
Crude or screened sewage	14.0
Filter effluent	10.5
Aeration tank effluent	4.5

With aeration tank effluent, the sludge was withdrawn continuously, the rate being controlled by a valve on the outlet pipe and the quantity measured by a weir between the outlet pipe and the sludge return pumps. At Essen Relinghousen, the sludge was passed through a fine screen (1 mm. mesh) before it was returned to the aeration tanks. The material retained by the screen and washed off with a stream of sewage was coarse and fibrous and was considered to contain little active sludge. It was pumped to the sludge digestion tank with the excess.

General.—The visitor is especially struck by the generally fine appearance of the Europeon sewage works. Most of them have attractive buildings and considerable planting including shrubs, vines, and flowers. Except where there was little or no attempt to digest sludge, odors were not in evidence, partly because of the fresh sewage and partly because of the clean condition of the plants.

There is a considerable range in the methods of treatment and the loadings as illustrated by the long displacement period in the English settling tank as compared with the short ones in the Ruhr valley works. The relatively low per capita quantities of sewage, brings more ample capacities within financial reach and the plants as a whole appeared to be less heavily loaded than many in the United States. Thus the strong sewages at Decatur and Ft. Worth, which approximate the strength of the Birmingham sewage, have nearly four times and twice the per capita rate of flow respectively.

Note should be made of the care given to the distribution of the sewage to the various units by vertical swing gates, weirs, and orifices. At Birmingham the inlet pipe to each settling tank is flanged and a vertical plate orifice inserted between the flanges with a valve on the inlet side. A U tube indicates the loss of head through the orifices and this loss is kept the same at each inlet throughout the battery of tanks.

Other points of interest related to the conveyor machines for removing sludge from drying beds at Stuttgart and Munich; and the general use of some form of storm water treatment.

The Beccari Plant at Scarsdale, N. Y.

Fermentation Process of Disposing of Organic Waste

By ARTHUR BONIFACE
Village Engineer, Scarsdale, N. Y.

IN THE choice of a method for garbage disposal, local conditions must of necessity govern the type selected and the fact that these conditions are different in almost every locality calls for the guidance of competent technical talent to solve the problem.

Why the Type Was Selected.—Perhaps the most difficult situation to meet is the one presented by the high class built up community with a population of about 10,000. Lacking an appropriate district to choose as the site for a disposal plant, the unmost caution must be exercised for fear of the effect its establishment would have on adjacent property.

It is under the latter category that Scarsdale takes its place and explains why the choice of plant fell to the one selected. Scarsdale is located about six miles north of the northern limits of New York City. It is known as one of the highest type residential communities in the east, has a population of about 9,500, embraces territory over six square miles, and has an assessed valuation of $50,000,000. Prior to 1923 its household wastes were removed by 15 private collectors, with the usual indifferent service that accompanies a method lacking governmental control. Therefore, during the summer of that year the municipality took over the collection and disposal of waste, and after extended study chose for the disposal of its organic waste, a plant patterned after the fermentation type much used in Italy. Its choice, primarily, was due to the fact that the building lent itself to architectural treatment, was simple to operate and further, that a humus could be produced bearing high value as a fertilizer.

To those not familiar with this method of disposal it may be stated that the Fermentation System established in Italy in 1914 first contemplated the reclamation of organic waste accumulated on farms, with a view not only to its salvage, but to an increase in its effectiveness as a fertilizer. Later the system was successfully applied to the disposal of organic waste produced by municipalities.

The plant erected in Scarsdale was an eight cell unit constructed of concrete, the design being practically identical with the units in use in Florence, Italy.

No reference will be made to the details of design, followed in the original structure built in Scarsdale, for reasons that will be obvious later.

Early Operating Results.—The plant commenced operation in December, 1923, following closely the methods employed in the Italian cities, viz., cells were charged to capacity with organic matter, hatches and side doors closed, and the contents left undisturbed for periods varying from 45 to 60 days, at the expiration of which the residue was removed and stored in the side sheds built as a part of the plant.

The humus produced in the early operations contained about 45 per cent moisture and on removal from the fermentation chambers emitted decidedly objectionable odors; moreover, it bore no resemblance whatever to the humus produced in the Italian plants, and although subsequently it was dried and ground and the work and nuisance involved in so doing made it undesirable to continue.

Numerous studies, investigations and experiments followed, all of which form an interesting chapter in the development of this means of disposal. It should be stated, however, that the early operation of the plant fell short of expectations, first—because, filling a chamber 9 ft. high with wet garbage resulted in producing a mass impervious to air, which was fatal to success, and second—the various components of our raw garbage seemed to produce an acid condition detrimental to the development of the biological processes.

The design and operation of a fermentation plant do not call for any complicated technique, only the observance of two fundamental principles, which are, neutralization of the mass and sufficient means of aeration in the cell after the mass has passed its initial stage of decomposition.

Details of Reconstructed Plant.—As reconstructed, the plant in Scarsdale consists of an eight cell unit, each chamber having a capacity of 20 cu. yds. The floor of the cell is graded so as to drain the liquid to the sump or sewer below. The interior is divided into five layers by means of gratings, spaced 18 in. center to center. These are constructed of 2 x 3 creosoted pine for ease in handling. Two small port holes for the admission of air are located just above the floor, and in the roof a six inch hole is provided for the passage of the gases generated in the mass below. There is a hatch on top for charging and a sliding door on the side for discharging. Connected to the outlet in the roof is an air washing chamber two feet in diameter and 10 ft. long in which a series of sprays are located; these are operated by a one inch centrifugal pump, and a one-third H. P. motor connected to a 50 gal. tank, charged with a 1:500 solution of potassium permanganate. The object of this washer is to remove any possibility of nuisance due to the emanation of gases from the mass during its early anerobic stages.

Practice at Scarsdale.—The practice followed in Scarsdale is to bring the raw garbage to the floor formed by the

roofs of the cells; here it is dumped and spread, and commercial hydrated lime in proportion of about 1½ per cent by weight is added to effect neutralization. To stimulate anerobic action a small quantity of ammonium sulphate in the form of a 10 per cent solution is poured over the mass. The garbage is then shoveled into the cell, and the process described repeated until each chamber is filled.

Immediately after closing the cell, a vigorous nitrifying action is noted, and the temperature gradually rises, until about the third day it has reached around 150 to 155° F., which it holds for three or four days, then slowly drops, according to the season of the year, to 110 degrees at the 30th day, when the residue may be removed, ground and bagged.

The quantity of humus obtained from one cell is 12 to 16 per cent by weight of the original charge, and when analyzed averages:

Nitrogen	2.59 to 3.00 per cent
Potash	0.60 to 1.76 per cent
Phosphoric Acid	2.64 to 3.50 per cent
Moisture	10.00 to 12.00 per cent

The humus is sold wholesale at $25.00 per ton, which yields a net revenue of approximately $22.00 per ton after deducting cost of treatment.

The procedure just described might give the impression of being involved, but all operations are conducted by common labor only.

Briefly summarizing, the process divides itself into two interrelated treatments. In the first stage, the garbage is enclosed in a cell against the access of air, thus stimulating the action of the anaerobic bacteria which cause the mass to break down and liquefy the readily decomposable elements. Passing into the second stage, the mass is subjected to a current of air at atmospheric pressure initiating the action of aerobic bacteria. The flow of air admitted through the small portholes and thence through the mass not only stimulates aerobic action, but tends to dry the contents of the cell, and finally a good grade of fertilizer is obtained, free from noxious odors.

Cost.—As to the cost of such plants, figures will differ according to locality, but roughly estimated, the cost is $2,000 per 1,000 population, or $20,000 for a village or city of 10,000. It would be well, however, to have several cells in reserve in case of emergency, which would add to the unit cost proportionately.

In designing the individual cells, a size should be chosen that would provide for its being filled within 48 hours, otherwise there is a chance of arresting the vigorous nitrifying action that commences almost immediately after the first two or three loads of garbage are deposited in the cell.

Important advantages over other methods of disposal are low initial cost low operating and maintenance costs, absence of noxious odors due to operation, complete destruction of the pathogenic germs, its high revenue producing possibilities, and ease of enlargement of plant without disturbance of original unit, as the municipality grows.

Its disadvantage is that it is essential to maintain the three-can system which in some localities might introduce considerable difficulty in the collection phases. It is necessary also to make provision for the consuming of combustible waste, but in the complete plant design there should be no difficulty in incorporating this feature. Putting it broadly, a fermentation plant accomplishes in one month what the old compost heap took a year or more to do, and does it minus the nuisance.

As has been pointed out, garbage disposal by fermentation is not new, Italy has used it for 14 years. What is new is the adaptation of the process to American conditions, which differ vastly from those of Italy, and, therefore, present serious difficulties not faced there.

Acknowledgment.—The above paper was presented at the 9th Annual Conference of the International Association of Street Sanitation Officials.

Horn Controlled Traffic Signal

Sound and light assume a unique duty as traffic policeman in a new scheme of control whereby the operation of traffic lights at certain outlying intersections is to be placed in the hands of the traffic itself. Under this plan it is claimed vexatious halts at isolated intersections when there is no cross-traffic for which to halt will be entirely eliminated. And pedestrians, accustomed to taking their chances at street crossings, are also cared for; in addition to allowing cross traffic to interrupt main traffic. the new system enables pedestrians to obtain right of way by pushing a button.

The automobile horn is a vital factor in the plan, devised by Charles Adler, Jr., of Baltimore, and being introduced by the General Electric Company. The sound of the horn starts an electric sequence that changes the lights.

Approaching a much-traveled main artery, the motorist in the cross-street finds himself stopped at the street-intersection by a red signal-light, and knows, of course, that the signal-light on the main avenue is green. He halts his car near a horn-like contrivance mounted on a pole at the curb. He honks his auto-horn.

Immediately a sensitive microphone inside the sound-collector on the pole picks up the noise, converts it into an electrical impulse, transmits it by wire to a control-box, and which operates the mechanism to change the lights.

The first thing that happens is the appearance of an all amber light in the lens below or adjacent to the red light,

Horn-Controlled Traffic-Signal Installation at Schenectady

informing the motorist that his signal has registered. A moment later he gets his green light, a red light appears on the main thoroughfare, and the cross-street car secures the right of way.

After a premeditated interval, the lights change back from red to green on the main avenue and from green to red on the side street. The timing cycle operated by the sound-controlled device is completed shortly thereafter, main traffic retaining the uninterrupted right of way at that particular intersection until the next cross-bound vehicle appears.

In case a second motorist, travelling through the cross-street, reaches the intersection just after the lights have changed back to favor main traffic, he cannot immediately get the right of way, even though he blows his horn at the sound collector. He sees the amber light, indicating his signal has registered, but the red light against him continues until the timing cycle is finished, whereupon he also receives a green light, main traffic receiving a red light.

There is also provision for push-buttons on the poles, so that pedestrians can operate the system and obtain the right of way when desirous of crossing main-artery traffic.

Several initial installations of the device, known as the G-E novalux traffic-operated controller, are already under way. It is expected to be particularly useful at outlying street-intersections and upon country highways.

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State Aid for City Highways

In a very interesting letter, published in the December issue of ROADS AND STREETS, Mr. J. H. Howe, City Engineer of Cresco, Iowa, comments upon our editorial article, "Why States Should Build Pavements Through Towns."

Mr. Howe says: "Heroic efforts are being made to get the country roads out of the mud, while in the cities and towns we are still in the ox team days so far as any legislation calculated to speed up the construction of modern paved streets is concerned." This is true, and our editorial article emphasized one aspect of the legislative problem, namely a more equitable distribution of the cost burden. We are convinced that there will be inadequate progress until the practice of assessing street construction entirely against abutting property is discontinued.

Mr. Howe points out that the "city fathers" are usually less to blame than the state legislators for the prevalent injustice of laws relating to taxation for street improvement. He adds:

"Many members of the legislature seem to find it better and safer politics to neglect the cities and towns, but have them pay the bills. They talk farm relief but not city relief."

There is a growing irritation among city residents over the distribution of gasoline tax money, for example. They complain that in many states the residents of cities pay more than half the gasoline tax, but get only a very small percentage of the benefit derived from the tax. We predict that this complaint will grow in volume until state legislators do give adequate attention to "city relief." As a first step in that direction we urge the improving of "through streets" with money raised by gasoline and other motor vehicle taxes.

We agree heartily with Mr. Howe that if state-aid is thus extended to cities and towns, it should not be limited to building street pavements only 18 to 20 ft. wide. A city street should not be treated like a country road. If state-aid is extended to cities and towns, state highway departments may well delegate to city engineers much of the designing and construction supervision of state-aid streets. Co-operation, in short, is needed between state and city engineering forces.

We may have been too severe in our criticism of the seeming inertia of the "city fathers" relative to changes in the practice of assessing street improvements. Where they are hampered by state laws, the inertia is not theirs alone. Yet it rests mostly upon them to initiate efforts to change the state laws. Perhaps city engineers themselves are even more responsible for the inertia than are the "city fathers."

A city engineer should be more than a technical expert on construction and maintenance of city works. His is also the province—if he will but assume it—of advocating economic reforms even in laws. No one knows better the defects of a law than the men who have to conduct their work under its prescriptions and proscriptions. The city engineer sees such defects almost daily, and he chafes under them. But the old conception of an engineer as purely a technician usually prevents city engineers from aggressively advocating changes in laws, for that is supposed to be a job for legislators.

Engineers who, like Herbert Hoover, have risen to high executive positions, have usually taken a very broad view of the province of engineering. They have regarded all phases of their economic problems as being essentially engineering, regardless of the prevalent practice.

If engineering is the application of science to problems of economic service, engineers should not hesitate to extend their activities into the uttermost parts of the social realm. Certainly there is as much need of scientific study of the economic effects of laws and ordinances as of the scientific study of strains and stresses. Who, we ask, is better equipped for such study of political economics than is the engineer?

"Engineering Schools Should Teach Economics"

Under the title "Engineering Schools Should Teach Economics" a recent editorial article in an engineering magazine criticized some alleged errors of an engineer and placed the blame for his alleged mistakes upon his apparent lack of training in economics. We agree with the editorial opinion that engineering colleges should teach economics; but we think that the editor in question himself exemplifies the very lack of economic training that he deplores.

The first criticism of the engineer by this editor was that he used 7 per cent instead of using about 5 per cent in computing interest charges on a municipal pumping plant. This criticism was probably correct if the municipality could borrow money at 5 per cent without straining its credit. Not infrequently engineers of railways, on the other hand, make the mistake of using a bond interest rate of about 5 per cent instead of using a "fair return rate" of about 7 per cent.

The second criticism was that the engineer had used a 7 per cent annual depreciation rate; and this editorial statement was made: "Now, if a depreciation charge is set up, the invested capital decreases each year by this amount. Consequently, the interest should either be calculated on the basis of a diminishing capital or a diminishing depreciation."

Neither the premise nor the conclusion is correct. If a depreciation charge is set up and if a sinking fund is established to retire the plant at the end of its life, both the capital investment and the depreciation rate should be regarded as constant. This is the ideally correct treatment of depreciation where no change in price levels occurs. An approximately correct method consists in using a depreciation rate determined by dividing 100 by the estimated life in years, and in that case an approximately correct result is obtained when the invested capital is reduced each year by the amount of the annual depreciation found by multiplying the "straight-line" rate by the original cost (not the depreciated value) of the plant. On short lived property this approximate "straight-line" method is often satisfactory enough, but on a long lived plant it leads to very incorrect results, for it is tacitly based on the assumption that the depreciation annuity can earn no interest, which is clearly erroneous.

The third criticism of this engineer is even more clearly wrong than the second criticism, yet it exemplifies one of the commonest of economic blunders. Says the editor: "To make the situation still more illogical, when comparing the cost of operation of the present plant and purchased energy, this engineer ignored the fixed charges on the present plant when estimating the cost with purchased power, even though the investment still exists in the shut down plant."

Here we see that the critical editor regards the original cost of an obsolescent plant as being an element that must be considered in ascertaining whether it is cheaper to retire it or buy electric current from a central station. As a matter of fact it is wholly immaterial what the original plant did cost. The problem differs radically from one in which two alternative new and rebuilt plants are being compared economically, or from a problem in which the cost of generating power with a proposed new plant is being contrasted with the price at which such power can be purchased. In the case of an old plant that is obsolescent, the problem is really whether its obsolescence has progressed so far that its true economic value is less than its scrap value, or not. If not, it should continue to be operated, even though its true depreciated value be but little more than its scrap value.

Stated differently, the problem then is to ascertain whether the operating expense (exclusive of interest charges) per unit of power generated by the old plant is greater or less than the price per unit of purchasable power.

The problems of depreciation and the allied problem of when to retire an old plant or plant-unit, have been discussed in the "Handbook of Mechanical and Electrical Cost Data" by Gillette and Dana, to which the reader is referred for full proof of certain of the statements above given.

In the course of a rather extensive experience, the editor has found more ignorance among engineers on the problems above mentioned than on almost any other economic matter.

Because of ignorance of economic facts and principles hundreds of millions of dollars worth of plant have been retired too soon, and other hundreds of millions have been kept in service too long. To emphasize the seriousness of the whole matter, we have just quoted from a prominent engineering magazine a criticism of an engineer in which the editorial critic displayed his lack of understanding of certain principles involved.

It is apparently the opinion of the majority of teachers of engineering that there is no necessity of teaching economics as a special subject, and that all the principles of engineering economics can be learned incidentally as a sort of by-product of one or more of the engineering studies. It should not be difficult to test this opinion by submitting the fourth year students to a thorough examination in economics. It may be that the editor has been peculiarly unfortunate in having employed so many graduate engineers who could not pass such examinations.

Ask a number of such questions as this: How would you determine what rate of interest to use in capitalizing annual expenses? The answers that the editor has received have almost invariably shown no appreciation that it is a real problem itself to determine the correct percentage. Throughout Wellington's "Economic Theory of Railway Location" a bond interest rate is erroneously used to capitalize annual expenses and to estimate that part of fixed charges that relates to interest. In the original appraisal of the franchise value of the railways of Michigan and Wisconsin, a bond interest rate was erroneously used in capitalizing net earnings.

There seems to be prevalent the idea that if correct principles are applied it is a matter of minor concern whether the alleged facts are correct. Last year's net earnings, for example, are often assumed to be typical, without a thorough study to show what is a typical year's net. Depreciation rates are guessed at, although usually they may be ascertained with considerable accuracy from past accounting records that are properly interpreted. Here again very few engineers that the editor has encountered in rate cases know how to derive a depreciation rate from past accounting records; most of them asserting it to be impossible because in the earlier years no distinction at all was made between maintenance expenditures and retirement (depreciation) expenditures. The problem can be readily solved none the less.

Like any other subject that attains the rank of a separate branch of science, economics should be studied by itself. Unfortunately that particular branch of economics known as political economy has come to be regarded by many as being the only economics. For the most part it still remains a mass of unproved hypotheses and hot air. Business and engineering economics, on the other hand, have largely emerged from the stage of unproved hypotheses. Still the data that must be inserted in the formulas are often woefully unsatisfactory. The lives of many kinds of machinery and structures are usually guessed at. Interest rates are guessed at. Even unit cost prices are often guessed at. Overhead percentages are often guessed at. All this, too, by many engineers who would be shocked at hearing themselves called economic ignoramuses.

If this state of affairs is not traceable to the by-product treatment that economics has received in many engineering colleges, then what is the cause of it?

H P Gillette

The Personnel of a Water Department

How Detroit Provides for Its Employees

By JOS. F. MAJESKI
Paymaster and Personnel Superintendent, Department of Water Supply, Detroit, Mich.

IN the operation of the department of water supply, the city charter places all employees within the jurisdiction of a civil service commission. This commission acts in a capacity similar to the employment bureau of a private organization, furnishing upon request from the personnel superintendent all technical and clerical help which may be required in the course of operation of the department. The civil service commission, upon receipt of requisition, certifies the first person from a list composed of eligibles who have successfully passed a competitive examination for the position which is desired to be filled. Also, all changes that may affect a certified employee's status must be submitted to the civil service commission for approval. Employees have the privilege of protesting dismissal and suspensions and may, if desired, request a hearing before the civil service commission.

Therefore, it can be readily understood that the problems involving the personnel department of the water supply are the same as those confronting other similar municipal and private organizations. Material effect of questions arising, relating to the successful operation of this department must be considered carefully and judiciously the same as other problems which directly apply to the department of water supply.

A person certified to a position in the department, and upon entering, is required to fill out an employment record card containing name, address, telephone number and other data, which gives the department immediate information for record acknowledgment. These records are visibly typed and filed for instant reference, showing every transfer, promotion or change; in reality, giving a working history of the employee from the date of entrance into the department.

How Vacancies are Filled.—Inspiration to extend every effort for best results and co-operation in the department is instilled in all employees by the fair treatment accorded them. In the course of operation of such a vast department vacancies occur within the various bureaus. These positions are filled in so far as possible from the ranks of the existing personnel, thereby affording the individual to qualify for whatever promotion may occur as a result of transfers, dismissals, resignations or promotions. This procedure is followed, within the jurisdiction of the civil service commission, by filing an application setting forth his or her reasons as to their particular adaptability to perform the duties of the position which has become vacant or newly created. This application, with all other records of the employee already on file, is considered by the head of the bureau in which the vacancy occurs, and forwarded to the personnel superintendent for his approval and recommendation to the civil service commission, who has final jurisdiction in the matter.

The benefits realized by enabling employees to rise in the department by promotion or transfer creates a keener interest in their work as well as the spirit of competition, knowing that upon them depends every effort of success or failure, thereby encouraging and obtaining the best results for co-operation, and ultimately successful operation of the department.

Conditions provided for the betterment of the employees and for the consideration of their services are well taken care of by granting adequate periods for vacations and illness, as well as general environments.

Vacations and Sick Leaves.—All employees in the service of the department continuously for one year are allowed two weeks' vacation with pay. Time of vacation periods is apportioned by the head of the bureau in such manner so as not to impede the operation of the department. In case of illness, an employee is allowed as many as 15 days' leave with pay absorbed during the period of the year, or necessitated continuously. If an employee is compelled, by reason of serious illness, to absent himself or herself for more than the usual 15 days' sick leave, then with the discretion of the board, an additional 15 days is allowed with pay. Any employee absent by reason of illness or otherwise is required to notify the head of his or her bureau within 48 hours, stating reason for such absence and probable date of return. A physician's certificate must be furnished in case period of illness exceeds more than three days.

The Working Day.—The city charter provides that eight consecutive hours constitute a day's work and that six day of eight hours each constitutes a week's work. Overtime is paid per diem employees at the rate of time and one-half after the completion of the eight-hour day and double time on Sundays, provided they have already completed a full forty-eight hour week, or six consecutive days of eight hours per day.

The magnitude of the responsibility of the pay roll bureau can only be appreciated by the fact that from Jan. 1, 1927, to Dec. 31, 1927, this bureau paid out in salaries and wages the sum of $4,650,471.72. The weekly pay roll, made up for an average of about 2,200 employees, amounted to $3,623,372.75, while the semi-monthly pay roll for an approximate average of 477 employees amounted to $1,027,098.97 for the same period.

The above figures give one an understanding as to the accuracy, with several processes of checking, required in the detailed routine of the execution of this work.

The Pay Roll Bureau.—All timekeepers report to this bureau every Monday morning with their time sheets, which are in loose-leaf form, to be checked in the timekeeper's presence, as to names, titles, rates and extensions. Any change in title or rate, within the ruling of the department, must be authorized by the superintendent of the division which the timekeeper represents. The rates of pay in all cases are required to be within the standard adopted by the board in their respective classifications. When pay rolls are checked and completed, they are subscribed and sworn to by the head of each division or bureau before the personnel superintendent, who is a notary, and then submitted to the civil service commission for checking as to names and tiles, thereafter passed on to the city controller for verification of extensions, and finally to the city treasurer for preparation of the checks. Upon receipt of the checks from the city treasurer, they are checked and numbered by this bureau to correspond with the pay roll. After this procedure, they are then ready to be issued to the employees on pay day. Any employee receiving his check must furnish a signed pay ticket, showing such receipt, which ticket is given him by the timekeeper, who procures same from this bureau.

Provision is also made in this bureau for the handling of discharges and lay-offs. During the last year 688 employees were either discharged or laid off, necessitating the amount of $15,-402.52 to be paid out in cash. It has been the policy of this department to pay off employees immediately upon discharge or lay-off.

Handling Complaints.—The department of water supply in its operation also comes in contact with almost all the citizens, business and industries of the city. Considering the number and diversity of interests encountered, it is to be expected that a number of complaints will be made in the course of each year. These complaints are principally those regarding water and service charges, those regarding the personnel and those involving property. Minor complaints regarding charges for services are mostly adjusted by the billing department, but the more difficult complaints are adjusted by the adjustment committee, which is composed of four members, namely: the general manager, engineer of water system, chief clerk, and the personnel superintendent, which committee in turn makes their recommendation to the board of water commissioners for their approval.

All complaints against employees of the department are referred to the general manager and by him placed in the

hands of the personnel superintendent. These complaints, though few in number and of minor nature, are given a most searching investigation and if the employee is found to have been guilty of the charges made, he is severely disciplined. Complaints involving property are seldom made, as those in charge of the department's construction and maintenance divisions are most solicitous not to injure any property in the proximity of their work. If it becomes necessary to destroy lawns or walks in the course of operation, immediate steps are taken to repair the damage.

Accidents.—In a business as large as that conducted by the department of water supply, in spite of all precautions that are taken, accidents do occur, but they are mostly of a minor nature. In the first place considerable time of the personnel superintendent is devoted to looking after accidents in which the motor equipment of the water department is concerned. A written report is made out by the driver and forwarded to the personnel superintendent and by him reported to the superintendent of city motor traffic division, after which a date for hearing is set and all parties involved are notified to appear for hearing in the city council chamber. This department is represented at this hearing by its personnel superintendent, who has prepared himself by personal investigation of the facts of the accident. If the employee is found guilty of negligence he is disciplined and compelled to pay the damages caused. Other automobile accidents occur at times when a car is damaged by coming in contact with the department's construction or maintenance work. An automobile may be driven into a trench or over a pile of dirt or material that has been placed in the roadway. These cases are investigated and if the department is found at fault compensation is allowed for the damages sustained. The employee at fault in such cases is severely disciplined. There were 110 accidents for the year 1927 which were disposed of as follows: Twenty-five city drivers were found at fault; forty-two private parties at fault, and forty-three were unavoidable.

Accidents to employees are given a most searching investigation. These accidents are not very numerous and when occurring are usually of a slight nature. Fatal accidents or accidents occasioning total disability are of rare occurrence. During the year ending Dec. 31, 1927, there was a total of 408 accident cases handled by the personnel superintendent. Every accident, no matter how trivial, must be reported and on the eighth day after this report, together with such data as the name, address of both the employer and employee, occupation, age and sex, date and time of day when accident occurred and the nature and cause of the injury, length of time lost, date of return to work, the name and address of the physician and hospital, and the amount expended for hospital and medical care, must be submitted to the State Industrial Accident Board.

Accident Compensation.—The department of water supply, under the state law, does not pay compensation unless the employee is disabled for a period longer than seven days. When an employee is not able to return to his work after seven days, additional information must be furnished to the state board, covering the question of compensation for the injured employee. During the past year there were 39 compensable cases and 360 non-compensable cases, constituting 408 accidents to employees. The compensable cases receive 60 per cent of the weekly wage, the amount not to exceed $18 per week. Should an employee lose a limb through accident, a fixed time during which compensation must be paid is set by statute. The loss of a hand calls for the payment of the compensation for 150 weeks. Should death result through accident, the person's dependents are entitled to 300 weeks' compensation. The total amount paid during the year amounted to $6,124.88, distributed as follows: Compensation for minor injuries, $4,668.88; to widows of men who have lost their lives, $1,456. Besides the compensation, the department is responsible for a certain amount of medical attention and hospital expense in all cases. It is the personnel superintendent's duty to see that this provision of the law is scrupulously complied with. The sum of $9,047.90 was expended for hospitals, doctors and medicine during the year. The personnel superintendent, in making his reports, must be absolutely fair, in order, on one hand to protect the department, and, on the other hand to see to it that no injustice is done the employee in the time of his great need. All hearings that come up before the state accident board are attended by him. He also arranges all payments concerning matters of compensation.

Acknowledgment.—The foregoing is taken from a descriptive survey of the Detroit Department of Water Supply, issued last October by the Board of Water Commission.

Cost of Operating Ford Runabouts.—During the fiscal year ending June 30, 1928, the Water Department of Pasadena, Calif., operated 13 Ford runabouts. The average cost, according to the 13th annual report of the department, was as follows:

	Per Mile
Tires and tubes	$0.00614
Gas and oil	.01142
Other material	.00506
Labor	.00954
Overhead	.00252
Depreciation	.00205
Total	$0.03733

The average mileage was 7,731. The average mileage per gallon of gas was 15.02 and per gallon of oil 513. The average total number of hours in service during the year was 1,980 and the total cost per hour was 14.58 cts.

How Cities Can Make Use of Wasted Space

By E. E. DUFFY

Cities in the future must give more attention to the elimination of waste space.

Of the several conditions hampering cities, now that the automobile has complicated transportation problems, one of the most in need of corrective measures is the elimination of "Chinese Walls" accumulated through the construction of retaining walls and fills by electric and steam railroads. It has long been the custom in elevating railroad tracks to build parallel retaining walls, filling in between them with earth, with occasional openings at street intersections.

Traffic authorities point out that barriers formed by such construction are not in keeping with modern needs. Instances are cited to show that this space under the tracks can be utilized to the advantage of both railroads and the general public. Such space, frequently valued at $250 or more per running foot, can be made available through simple and economical construction of supporting columns and deck.

Three uses for this space are apparent; business, parking and automobile traffic arteries.

In the Wilson Ave. section of Chicago, space beneath the electric elevated lines has been successfully converted into business property. This improvement benefits both the railroads and the public.

An excellent example of the use of space that otherwise might be wasted is at the East Orange, N. J., station of a large railroad. Underneath the elevated tracks and near the station provision has been made for the parking of numerous cars.

Engineers point out that where four tracks are elevated, the ground space under the superstructure is about 60 ft. wide. With the proper spacing of the supporting columns, at least three cars can be parked for each 8-ft. length. The yearly income from this 8 ft. of land would be equivalent to the annual interest income from $3,000 to $4,000 and in addition motorists would have a convenient place to park.

This 60-ft. width could also be utilized as a thoroughfare for automobiles, with room for two or three traffic lanes traveling in each direction. With traffic congestion in many cities costing almost unbelievable sums, it is entirely logical to expect cities and railroads to co-operate for such usage, traffic planners declare.

Automatic Self-Cleaning Grit Chamber

A New Development for Sewage Disposal Plants

AN automatic, self-cleaning grit chamber designed for general use in place of the conventional grit settling troughs at sewage disposal plants has been introduced by The Dorr Co., New York. Its name, "Dorr Detritor," has been taken from the word "detritus," which is usually used to refer to the inorganics in sewage. This machine, it is stated, performs all the functions of the grit settling channels and in addition automatically collect and wash the grit, delivering it finally in a clean, dewatered condition to a suitable receptacle.

The plan and elevation views of a typical detritor installation are shown in Fig. 1. It will be noted that the detritor is located directly after the bar screen and consists essentially of four chief parts—a grit collecting tank, a collecting mechanism, a grit cleaning channel and a cleaning mechanism.

The collecting tank (Fig. 2) is square and shallow, the sewage entering along one side and being straightened out in parallel lines by a series of adjustable guide vanes or deflectors equally spaced along the influent side. The purpose of the collecting tank is to reduce the velocity of the incoming sewage to such an extent that practically all of the particles of grit of a predetermined size may settle out within the bounds of the tank. The sewage passes out of the tank across a weir which extends along the effluent side.

The collecting mechanism, a modification of the Dorr traction clarifier, consists of a combination of radial arms fitted with plow blades and an oscillating truss to which plow blades are attached. The radial arms sweep the area of the bottom bounded by a circle inscribed within the square tank, while the oscillating truss sweeps, in addition, the corners of the tank which are not reached by the radial arms. The mechanism is supported by a roller-mounted table on a central column. The oscillating truss, which is free to slide radially on the table, is attached at its outer end to a motor-driven carriage which runs on a rail on the tank top and drives the entire collecting mechanism. The plow blades move the grit outward toward the tank sides, where it is picked up by the buckets on the ends of the radial arms and deposited in the grit chute.

The chute discharges the grit into the narrow, rectangular inclined cleaning channel (Fig. 3) which extends from a point well below the water level at its lower end tor a point above water and adjacent to the grit container at its upper end. The cleaning mechanism has a reciprocating motion, the rakes

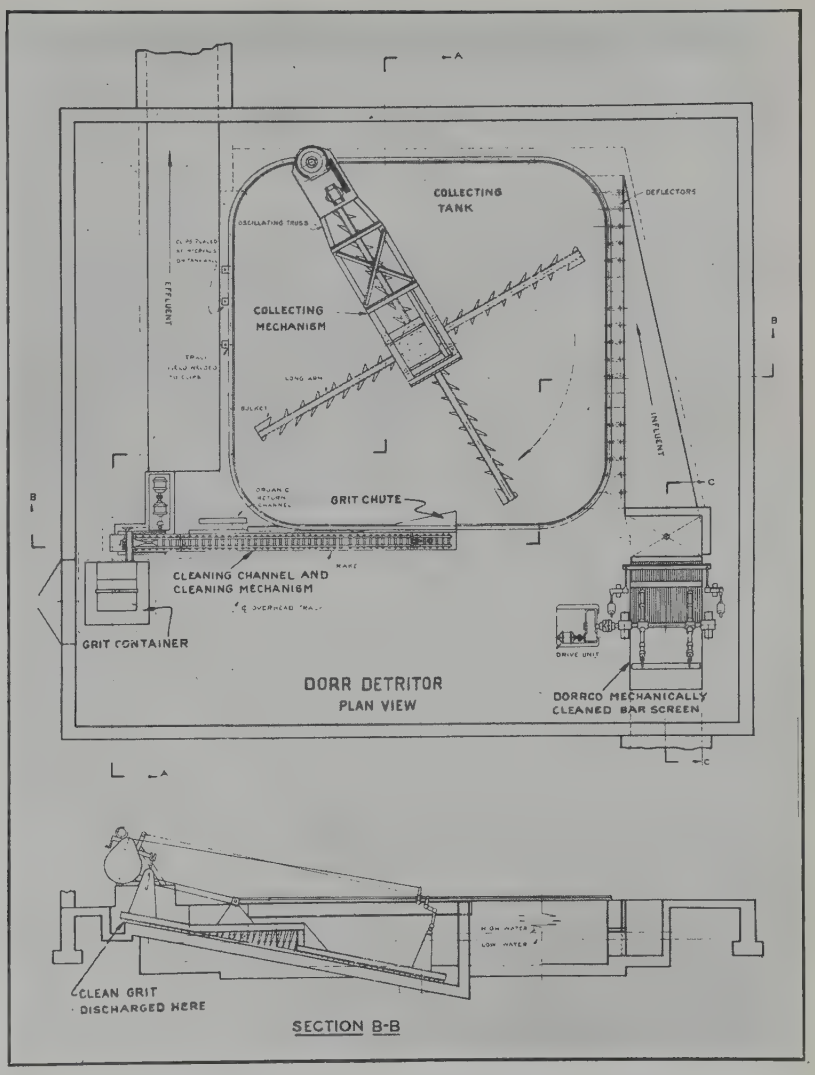

Fig. 1—Plan and Elevation of a Typical Dorr Detritor Installation

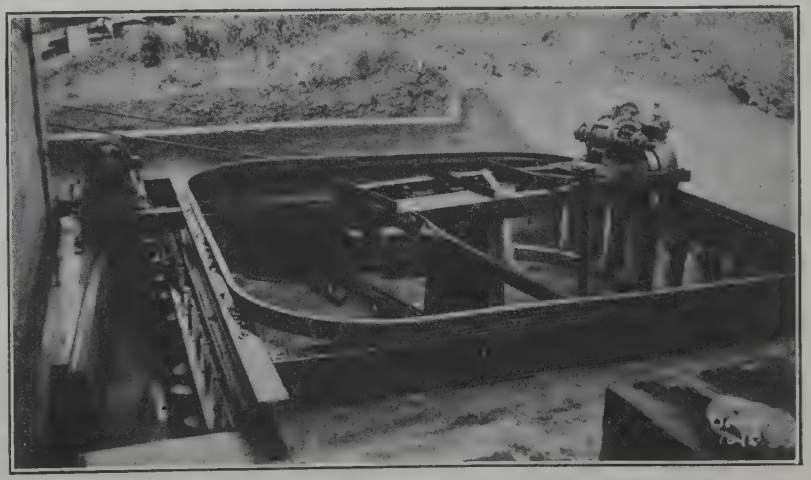

Fig. 2—Collecting Tank and Collecting Mechanism of Dorr Detritor

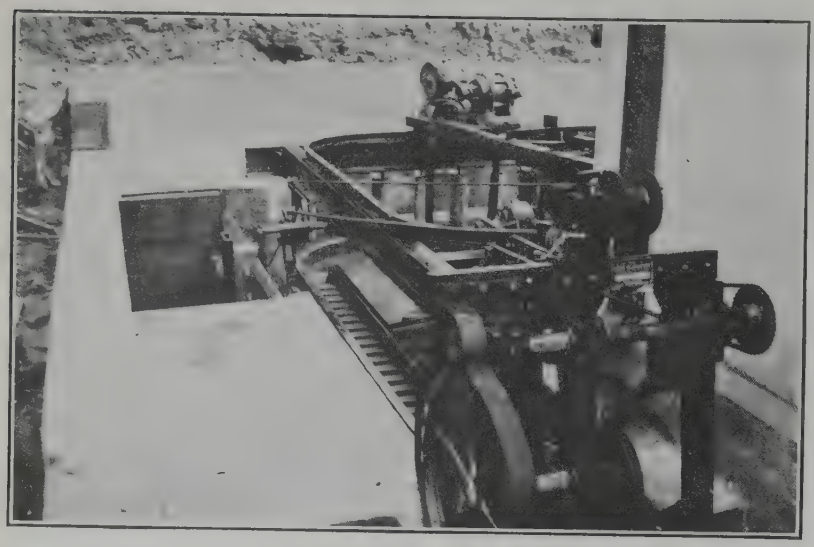

Fig. 3—Cleaning Channel and Cleaning Mechanism of Dorr Detritor

just clearing the inclined bottom and not only advancing the grit toward the point of discharge, but also imparting to it a turning over action which releases entrained organic matter. This released organic matter is kept in suspension by the gentle selective agitation of the cleaning mechanism and flows back into the collecting tank through an organic return channel in the dividing wall. This selective agitation, a result of the rake action over the inclined bottom, is stated to be just sufficient to wash back bulky organics but not the more dense sand grains.

The washed grit is drained on the above water section of the inclined channel and discharged into a grit container in a dewatered, odorless condition. As the grit is cleaned mechanically, it is unnecessary to maintain an exact velocity of flow across the collecting tank. While it is true that a velocity less than the maximum for which the machine is designed will cause the deposition of more organic matter with the grit, these organics are automatically removed subsequently in the cleaning channed and do not affect the character of the washed grit. Accordingly, duplicate units are not generally required for the control of velocity with varying volumes of sewage.

An extended test period at the initial commercial installation of the Dorr detritor is stated to have shown that the greater part of the grit of almost any fineness could be recovered and delivered to the containers with a putrescible organic content never exceeding 10 per cent and averaging over several months not over 5 per cent. That the washing has been carried out satisfactorily is evidenced by the present condition of the grit which has been recovered by the detritor over the last nine months at this plant. The grit has been exposed to the air ever since the equipment was put into operation, and in spite of exceedingly warm weather during the first few months, it is said, no obnoxious odors have been given off and there has been no evidence of a change of character that could be considered objectionable.

Nine Municipal Radio Stations in U. S.

Out of eleven municipal radio stations in the world, nine of them are located in the United States, one in South America, and one in Europe. Among those in the United States are: WPG, Atlantic City, N. J.; WCAM, Camden, N. J.; WRR, Dallas, Tex.; KGEW, Fort Morgan, Col.; WJAX, Jacksonville, Fla.; WCOA, Pensacola, Fla.; KKP, Seattle, Wash.; WNYC, New York City.

The New York station is operated by the Department of Plant and Structures of the New York City government, having been in operation for over four years, is the veteran among municipal stations. In 1927 over 1,689 hours were employed by this station in broadcasting; 720 hours were given over to vocal and instrumental music and nearly 1,000 hours to informational and educational programs; 320 balanced programs were given, including 80 lectures on municipal problems and 384 talks upon educational subjects.

WCOA, operated by the City of Pensacola, Fla., has been in operation only about three years and has given very great returns for the $7,600 a year which constitutes its budget. The officials at Pensacola believe that they are the only station which regards its main function as that of community building, developing local talent, encouraging young and aspiring musicians and players. Aside from this feature, they, like WNYC and WCAM, broadcast weather reports. These have been highly beneficial, especially to the fishing fleets sailing out of Pensacola.

In St. Louis the radio is used by police to broadcast news of major crimes. A private line connects the microphone on the desk of the chief of police with station WIL. This is to be followed up by installation of receiving sets in all station houses, and possibly in police atuomobiles. Detroit has also used the radio for some time in the police department.

In Baltimore the mayor's office has been outfitted as a broadcasting station so that meetings of the board of estimates and the board of awards may be heard from one's easy chair at the fireside. Conferences between delegations and the mayor will also be broadcast to those interested.

Airport Is Proper Municipal Function

The airport bonds approved by the voters of Kansas City and St. Louis, Missouri, last August were held invalid by the Missouri Supreme Court because of the cities' failure to revise the registration lists as required by law. The St. Louis issue was $2,000,000, and the Kansas City issue was $1,000,000.

At the same time, however, the court held that a municipal airport was a proper municipal function, saying:

"The courts which have had occasion to consider it have, however, answered in the affirmative; and no court of last resort, so far as we are advised, has ever held to the contrary. Not only that, but the function involved is given tacit recognition in numerous statutory enactments, both State and Federal. We have no doubt of the soundness of the view which obtains.

"With respect to the public uses which each subserves they are essentially of the same character. If the ownership and maintenance of one falls within the scope of municipal government, it would seem that the other must necessarily do so. We accordingly hold that the acquisition and control of an airport is a city purpose within the purview of general constitutional law."

Airports 3 Miles from Cities.—The average distance of airports from the business centers of municipalities in the United States is about three miles, according to a study made of such facilities in 436 cities by the Aeronautics Branch of the Department of Commerce. Considerable variety prevails, however, in the individual cases, some airports being within ¼ mile of the business district, and others being as far out as 18 miles. As might be expected, the larger the city the greater is usually the distance to its airport from the downtown section. In a number of municipalities of more than 100,000 population, the average distance to the airports was found to be approximately seven miles.

Water Works Improvements on the Cost Plus Basis

How an Iowa City Solved Its Reconstruction Problem

By H. V. PEDERSEN
Manager, Water Department, Marshalltown, Ia.

FEW managing boards of water works systems either municipally or privately owned are blessed with an over supply of funds for reconstruction purposes. In fact, it is common rather than exceptional for a water works department to be continually saving its surplus funds in order to retire bonds 15 to 20 years after an improvement has been made rather than to save them for future improvements. Wherever a city or private corporation has permitted its water works system to run down to a point where it must go heavily in debt to raise funds for necessary improvements, it takes a long time to get out of debt. It seldom ever does, for as soon as one bond issue is retired, the system is again in bad shape and because of lack of funds additional bonds are issued to raise the money for the improvement. In raising funds for water works improvements the private corporation cannot of course be compared directly with a municipality, but the same reluctance to spend money for reconstruction purposes exists in either case. As a rule it is comparatively easy to secure permission from either stock holder or the general public to raise funds for extension of mains, as most people readily understand that each additional block of new water mains increases the income from water rentals. In other words, there is less objection to spending money where the increased revenue will either pay for the improvement or bring a fair rate of interest on the money invested. A bond issue will usually be approved for raising funds to increase a supply of water whenever the public fully realizes that its supply is insufficient, but to tear down an old pumping station no matter how bad its condition may be and rebuild it is quite a different matter. As long as any public building hangs together it is difficult to make a majority vote in favor of a bond issue for reconstruction purposes.

It is this reluctance on the part of the public to believe that any city property, especially a water works system, should ever wear out which has compelled water works managements in many places to put off the evil day of reconstruction as long as possible and then when something must be done to prevent disaster to seek ways and means of getting by as cheaply as possible. The mere thought of a bond issue precipitates a fight and mud begins to fly in all directions, originating in most cases from sources least informed on the subject. Working on the assumption that a small bond issue will be approved more readily by the public than a larger one, the funds if secured at all are usually insufficient and the improvement suffers accordingly. Just how one Iowa city worked out its reconstruction problem might be of some interest.

Marshalltown Reconstruction Program.—The city of Marshalltown, Ia., was compelled to rebuild an original section of its pumping station this last summer. When the Board of Water Works Trustees first took the matter up for consideration it decided that no matter in how dangerous a condition the old building might be, there was little use in asking the public to vote on a bond issue. Every member agreed that, if there was any way to raise the money without a vote of the people, it was the thing to do, as they all felt that a bond issue would be defeated. A plan was finally worked out whereby a 2 mill levy authorized by state law and already received by the water department out of city taxes was pledged as security. A total sum of $50,000 was raised for water works improvements by practically mortgaging the water works property and pledging a certain definite source of income as security. No objections were raised to this plan and the bonds were issued and turned over to a bank for safe keeping to be sold only where the money was needed, thereby saving several hundred dollars of accrued interest.

The original water works pumping station at Marshalltown was built in 1876. This portion together with a number of later additions were in very bad shape. The walls were cracking and crumbling and the metal roof was practically eaten away. After careful investigation and study of the old structure it became apparent that a floor space area of 50 ft. wide and 130 ft. long had to be completely torn down and rebuilt while keeping the pumping units and boiler room in operation.

Cost Plus Plan.—After deliberation the Board of Trustees decided not to employ an outside architect and instructed its superintendent and general manager to prepare a set of plans and specifications. While investigating the condition of the old foundations and working out desirable changes, the writer became convinced that the probability of uncertain quantities which could not be determined until after the old structure had been torn down would make it extremely difficult to estimate the cost of the improvement. It was likewise believed that a contractor could not prepare an intelligently fair bid and would of necessity increase his estimated bid to take care of uncertainties. In order to insure a good job and at the same time keep the cost within a reasonable limit it was suggested that the work be done on a cost plus basis.

At first the idea of cost plus did not appeal to the members of the water board and one member was very definite in his objections. However, after each member had gone over the prepared plans and were shown the difficulties involved and after it had been pointed out that a limit could be placed on the contractor's plus they unanimously decided that money could in all probability be saved by doing the work on a cost plus basis. A contract was accordingly drawn up to fit conditions, extracts of which are as follows:

The first party (Water Department) agrees to place orders for, buy and pay for all materials necessary for the completion of this work.

The first party agrees to pay second party at the end of each week an amount equal to the second party's weekly payroll, on presentation of an itemized payroll sheet which shall be subject to check and approval by first party's water works manager.

The second party estimates the cost of rebuilding and reconstruction as defined by the plans and specifications at $..... and agrees to tear down the old building and rebuild it and dispose of all rubbish and do all of the work necessary to complete this contract as provided by the plans under the direction of said manager and in such a manner as will not interfere with the operation of the pumping units and boiler plant on a basis of such estimated cost plus $..... for his services and the use of his tools and equipment and it is agreed by the second party that if 10 per cent of the actual cost of material furnished and paid for by first party and labor furnished by second party and paid for by first party is less than the sum last above specified, then second party shall receive and be paid as compensation only 10 per cent of the actual cost. That in any event, the amount received by second party shall not exceed the sum of $..... above specified, notwithstanding the cost of the work, is greater than the estimate of $.....

Bidders blanks were prepared and bids called for. Instead of the contractor entering a bid for the total sum for which he would do the work, he simply stated the amount which he was willing to accept for his services and use of his equipment. A definite sum would be his clear profit in spite of the cost of the job.

Bids were opened on July 6, 1928, with four local contractors bidding. The estimates of the cost of the job ranged from $13,500 to $16,500 and the contractor's compensation from $1,200 to $1,500. The Board of Trustees considered the bids and awarded the contract to the contractor who they believed to have the best equipment for doing the work and who had also had the most experience. The estimated cost of the successful contractor was $16,000 and his compensation was to be $1,275.

Active work of tearing down and re-

construction began July 24 and continued until Oct. 1, 1928. A building 50 ft. wide and 100 ft. long together with a reinforced concrete coal room 25 by 50 and 22 ft. high, steel trussed roof spaced 16 ft. 10 in. on center, cost a total of $16,756.49. The materials cost $9,263.12 and the labor furnished by the contractor amounted to $3,961.35. Five masons, six carpenters and three laborers were the maximum employees furnished by the contractor at any one time. All the rest of the labor were supplied out of the regular water works employees.

The job progressed rapidly and was completed two weeks earlier than anticipated and a first class job was done in every respect. Marshalltown now has a well built pumping station of which it can be proud, at not too excessive a price. There are times when a straight contract has its advantages and is preferable, but when it comes to reconstruction the cost plus basis certainly works. If you have a questionable job, one which involves probabilities of extra quantities and desire first class construction, then buy your own materials and guarantee the contractor a definite profit.

Acknowledgment.—The above paper was presented before the Missouri Valley Section of the American Water Works Association.

Sewage Disposal in Mexico

An Outline of Present Sanitation Conditions

By ANASTASIO GUZMAN

MEXICO is just now beginning the development of sewage treatment methods. The chief cities have been provided with sewer system for a number of years, including Mexico City, which has a complete system that has merited the praise of many foreign engineers. The design of a sewer system which would be satisfactory in Mexico City was a very hard problem because of the nature of the soil and the flatness of the earth's surface. But by careful study and an expenditure of great sums of money, a satisfactory system was installed. Health conditions in that city as in others were noticeably improved with the use of sanitary sewer system.

Sanitation in Small Municipalities.—At present officials in many of the small cities and towns have become interested in the subject and the municipal governments have begun the preliminary work. Since most of the states are falling into line, we can say that the first part of our sanitary engineering problems is solved.

The above applies only to the building of sewer systems. With regard to treatment plants, we cannot say so much. In Mexico there is very little sewage treated. We dispose chiefly by dilution, which is the easiest method. The sewage is merely discharged without treatment into the streams which by themselves get rid of the sewage without causing any nuisance. The flow of the rivers is so great in comparison with the amount of sewage as to insure proper dilution. Of course these streams are never used for water supply purposes, but are frequently employed for irrigation. It must be remembered also that our streams are torrential, flow long distances and have many falls. In this way the sewage undergoes a natural process of purification. Our drinking water, as a rule, is derived from springs, artesian wells, and from rainfall collected in surface reservoirs, and we have always found these waters pure and good.

Combined Sewer Systems Common.—The sanitary and storm sewer systems are usually combined. In many small towns and villages, and especially those which are far from the principal cities, the use of the old primitive system of dry sewage is followed, which is bad. Some chemicals are used. In small private properties that cannot make connections with any sewer system, septic tanks are recommended. In some large factories the waste water is treated before being discharged into streams, and for such treatment small individual plants are installed. In one important city in the northern part of Mexico, there are large septic tanks, the effluent from which is used for irrigation.

Because of the many favorable natural conditions we have up to the present time been able to get along without sewage treatment, but these favorable conditions are now passed and sewage treatment is becoming indispensable. The small cities and villages are growing rapidly, the principal cities are enlarging their districts in the outskirts. In other words, the population is beginning to concentrate in cities just as in the United States. We have found, therefore, that in many places where the climate is delightful, people have crowded together until we find the water supplies being polluted. We are indeed beginning to feel a real need for adopting appropriate sewerage systems.

Conditions in Greater Part of Mexico.—Mexico City is a special case in itself, due to the great population which is growing daily, but in brief and general terms the conditions existing in the greater part of Mexico today are about as follows:

In the northern part of Mexico we have practically the same conditions as in the state of Texas; the climate, land and other circumstances closely resembling. The cities of this region are commercial and industrial. In the middle of the country and toward the western part, and in many places in the south, also, we have excellent climate without noticeable changes in temperature. There are many streams and the topography is broken—rather mountainous and rough—and from this we expect to obtain some advantage. On the coast and in the south, the climate is very warm, although the winters are very pleasant, and the changes in temperature will not give us any trouble. The principal sources of water supply are almost entirely independent of the rivers. One other factor which will help in making possible good sewer systems is the improvement in transportation and means of communication. We have a special commission on roads and highways which is now working constantly to extend good roads all over Mexico.

Although modern sanitary science is of recent development, and our problems in Mexico have arisen only recently, we have many experiences, works and studies from which to draw knowledge for future development. We hope to use some of the things which have been discovered in the United States and be able to skip over some of the mistakes made. In other words, sanitary work in Mexico can be started now upon a stable basis rather than having to go through the early stages of experimentation as has been done in the United States.

Only nine years ago did we begin to offer courses in sanitary engineering for the student of civil engineering, and these courses have been improved from year to year. We now have a curriculum which includes all that is covered in such courses in the United States and Germany. A few years ago the Board of Health of the Republic of Mexico undertook a great campaign to bring about the control of diseases, and to insure pure foods and drugs. The first meeting of the health officers of the various states in Mexico was held only last month. Through these meetings it is hoped to unify all these authorities just as you have done in Texas through the Texas Association of Sanitarians, and in the United States through the American Public Health Association. In the near future we hope to be able to establish in the various communities the necessary machinery to insure adequate protection of public health, welfare and happiness.

Acknowledgment.—The above is an abstract of a paper presented at the 6th Sanitation Short School, San Antonio, Tex.

Bond Issues for Sewerage and Water Works in Ohio.—Numerous municipalities in Ohio voted in November on bond issues for water supply and sewerage improvements. A total of $6,519,000 of bonds was authorized by 10 municipalities on water supply purposes, and a total of $2,203,000 was authorized by 8 municipalities for sewerage purposes.

Municipal Swimming Pools

Some Notes on the Water Supply Practice in the United States

By A. M. CRANE
Engineer, International Filter Co., Chicago

MUNICIPALITIES are competing with amusement parks and providing pools holding one, two and three million gallons. This is quite a draft on the municipal supply—unless refiltration be employed. The majority of wading pools do not use refiltration but are supplied with a constant flow of new water. This must mean something even in a city as large as Dallas. There they have about 20 wading pools, most of them about 30 ft. by 50 ft. in area. So the water demand is something which concerns the water works man, even if he is not called upon for advice in the planning of the pool. But in many cases he is called upon, and this is as it should be.

State Laws on Bathing in Potable Waters.—A few months ago, the writer, acting for the American Association for Promoting Hygiene and Public Baths, addressed an inquiry on this subject to the health authorities of our 53 states, territories, and island possessions and the result is given in the 1928 Journal of the Association under the title: "Promoting Pools by Prohibiting Bathing in waters Used for Domestic Purposes." This shows that actual state prohibition of bathing in domestic water supplies exists in California, Connecticut, Massachusetts and New York.

Kansas and Maine and perhaps other states have the authority, but have not enacted regulation. In Montana and probably other states, there is no specific enactment; but it is prohibited under general laws governing sanitation of surface waters. In Illinois, Louisiana, Maine, New Mexico and doubtless elsewhere, it may be, and is, prohibited by city ordinance or water company charter.

Down in Texas, a recent court decision restrained the use of a swimming pool in the Navasota River because it emptied into and polluted the lake of water impounded for domestic use by the city of Grosbeck. The California State Board of Health's swimming pool rules expressly state: "Disposal of swimming pool water can not be into a drinking water supply." But, on March 23, 1927, New Jersey set a horrible example by nullifying a regulation of the state department of health and enacting a statute specifically granting the right to bathe in any of the fresh waters of the state. This statute reads:

"It shall be lawful to bathe or swim in any of the fresh waters of this state, provided, that in so doing no trespassing be committed."

Of course this is all part of the broad subject of stream pollution; but while seeking to prevent contamination by sewage and industrial wastes, it will be well to remember that excretions from one typhoid patient might start a first class epidemic.

Now, if we can't bathe in the river or the reservoir—and we shouldn't bathe in the river or the reservoir—then we must have pools. And as the cry is not only for more pools, but for bigger and better pools—the whole subject is of vital interest to the city engineer and water superintendent.

Earlier Pools in U. S.—The earliest pools in this country were merely enclosures in the rivers. Then scows were used. In 1915 New York added a refinement by making its floating baths watertight—so as to prevent seepage, and supplied them with water from the city mains.

Indoor public baths came into use in Philadelphia in the eighties. In these, the pool area was not roofed. Consequently they could not be used in cold weather.

According to the late Dr. Simon Baruch, who is credited with being the founder of the public bath movement in the United States, in 1900 there were only 67 public pools in this country.

In 1913, the writer located only 540 pools in the whole United States. Of these 250 reported their dimensions. They ranged from 10 ft. by 20 ft. to 65 ft. by 140 ft.

The popularity of the pool has grown to such an extent that the first class ocean liner is incomplete without one. Right at this moment the United States shipping board is installing them on the former German ships "Monticello" and "Mount Vernon."

In the U. S. army, 59 establishments have pools—the largest entirely artificial one being 55 ft. by 169 ft. at Camp Harry J. Jones, Arizona.

It is the increasing size of the present-day pool and the state requirements as to water supply that makes the subject of particular interest to the waterworks man.

While 15 years ago a 65 ft. by 140 ft. pool was considered a large one, to-day the pools in our parks are rapidly approaching those of ancient Rome.

Increase in Municipal Pools.—Today cities are vying with amusement parks in building artificial pools which would take the entire output of a small town water works.

For example: The pool which is to be built for Elizabeth, N. J., will be nearly as large as Magner's Pool at Rye, N. Y., which holds 502,000 gal.; and the municipal pool at Estherville, Iowa, holding 375,000 gal. is nearly in this class. East Cleveland's municipal pool, holding 500,000 gal., is almost in the class of the nearby Idora Amusement Park pool at Youngstown, Ohio, which holds 740,000 gal. There are several other municipal pools now being planned which will run as large or larger than Chester Amusement Park at Cincinnati, which has a capacity of nearly 1½ million gallons.

In 1915 the American Association for Promoting Hygiene and Public Baths adopted suggested standards for swimming pools, including one reading as follows:

"Unless there is a constantly inflowing stream of absolutely pure, clear, colorless, fresh water, this condition should be approximated by filtration, refiltration and disinfection."

State Regulation of Swimming Pools.—At that time only one state—Louisiana—had any regulations and they did not go into details of the water supply; but now 27 states have definite and arbitrary regulations and 21 states require that plans must be submitted, or a permit secured, or the pool registered with, or reports made to the state board or department of health.

There has been a wide divergence in the state regulations but they are becoming more uniform since the promulgation of the report of the joint committee on bathing places of the American Public Health Association and the conference of state sanitary engineers.

Thirteen states now specify a definite degree of bacterial purity. Of late the tendency has been to stipulate the results, rather than to specify the means thereto.

New Mexico is a good example of this. Formerly they required 800 to 2,000 gals. per bather; now they do not specify any quantity of water but limit the bacteria content to the U. S. treasury department standards for drinking water. But several states still require a definite quantity. California wants 1,000 gals. of new water for each bather in "fill and draw" pools, to which they and other authorities are opposed. (California recommends circulation and refiltration daily.) Kansas requires and South Dakota recommends—1,000 gals. for each 15 persons using the pool during any period of time. This is equal to 66 2-3 gals. per bather. Virginia cut down its former recommendation of 500 to 800 gals. to 100 gals. per bather, and is now being guided by the joint committee's report. The "suggestions" of Georgia name 600 gals. per bather as the desirable quantity.

For "fill and draw" pools, Arkansas, Florida, Mississippi, Tennessee, Washington and Wyoming are satisfied with the "weekly bathing load of 20 in." (equal to 50 gals. per bather), suggested by the joint committee, but "prefer" a constant flow of new or refiltered water equal to "400 gals. per person per day considered on an average daily attendance." Oklahoma absolutely requires 400 gals. per bather both for "fill and draw" pools and those where refiltration is employed.

Use of Refiltered Water.—Of course if the demands either as to quantity of water or degree of purity had to be

met by a constant flow of water from the city mains, there would be fewer pools.

But refiltration makes it possible to use the initial supply (with a daily "make-up") for weeks or months without emptying the pool. The writer's survey in 1913 disclosed only 54 out of 272 pools employing refiltration. Today refiltration is universal. There may be a few city fathers who can't see why they should spend money for filters for the park pool just after they have paid for a city filtration plant; but they are getting fewer every day. When refiltration was first practiced—about 20 years ago, it was chiefly in indoor pools and to conserve the water and heat. Today, health is the primary reason for refiltration—although without it, the cost of operation would prohibit pools in many places.

Refiltration not only conserves water and heat, but keeps down the contamination of the water by the bathers.

Diseases from Unfiltered Pools.—In 1915 Dr. Manheimer cited 19 authorities who had reported venereal, ocular, aural or intestinal diseases contracted from swimming in polluted water. In 1929, Professor Hinman, one of the foremost investigators of the subject, tabulated the diseases as follows:

1. Intestinal infections, such as typhoid fever, dysentary, etc.
2. Infections of the respiratory system such as gripps, colds, sore throat and sinus infections.
3. Eye and ear infections, such as conjunctivitis, rhinitis, and ethmoiditis.
4. Gonorrheal infections.
5. Skin infections.

Reports of infections contracted by children in wading pools and tests showing highly contaminated water, have impelled the American Association for Promoting Hygiene and Public Baths to undertake an investigation of this subject. So far we have received reports from 87 pools and these show that the average area is as large as the swimming pools reported in our survey of 15 years ago, although the average maximum depth is necessarily lower, this being 20 in.

In the majority of these wading pools it seems as if there is a constant inflow while the pool is in use.

Out of 54 of these pools, 30 of them refill daily, two, twice a day, three, four times a week, six, three times a week, six, twice a week, and seven, once a week.

It remains to be seen whether or not the A. P. H. A. and state sanitary engineers will take cognizance of the situation; but a number of the members of both organizations have expressed themselves in agreement with our feeling that authorities should ordain the same standards of purity for wading pools as for other "Bathing Places."

Of course it would be quite unnecessary to go into structural details which should be left to the architect or engineer; and it would be impracticable and prevent an increase in wading pools to require a pre-cleaning shower; but the lack of a "scrub" and the fact that many of the youngsters wear dirty clothes which are immersed in the pool, making imperative a constant flow of pure water.

The sum total of this whole argument is:

1. The increasing size and growing number of swimming pools and wading pools demand the interest of waterworks men.

2. So far as purity of water supply is concerned, both swimming pools and wading pools should be considered on the same basis.

3. Unless there is a constant inflow of pure new water, this should be approximated by refiltration and disinfection.

Use of Dye in Underground Leakage Surveys

A dye test method of locating underground leakage has been used with excellent results by the Underground Leakage Section of the Department of Public Works of Chicago. The method was developed for use where the mains are at extreme depths below the street and where the mains lie in water bearing soil. This condition exists particularly in South Chicago where many mains are at depths varying from 11 to 12 feet below the present street level. Mains in this section of the city were laid in marshy ground 40 to 50 years ago and the street grades were gradually raised until the water mains and services are at the depths stated above in soil which is constantly filled with water. The mains and service pipes up to the stopcock are invariably covered with water or are water bound, in which condition very little or no sound is transmitted by the leaking water. The locating of underground leaks under such conditions is almost impossible when ordinary methods are resorted to. The dye method of testing to determine the location of leaks under such conditions was developed by William B. Weldon and Leonard Mauel who have been in direct charge of the field parties on this work. The method may be briefly described as follows:

After a section of main has been isolated and the service pipes shut off, when leakage is indicated, a vegetable dye (fuchsine) which colors the water red is passed into the pipe at the location of the by-passed valve. This dye is contained in a tank under sufficient pressure so that it can be forced into the main under test. The rate in feet per second at which the dye colored water in the main is moving can be determined by considering the cross section of the main and the volume of water being recorded by the master meter. After this rate has been determined the service pipe is disconnected at the first house meter and the water is drawn off in a volume equal to the contents of the service pipe. If the dye has reached this point in the computed time, the water is shut off on the service pipe and the next service pipe opened and similarly tested. When a point is reached where the dye does not come through the service pipe in the computed time, it is necessary to draw off the uncolored water until the dye-colored water appears. The water thus drawn off is measured and when the volume of the same is divided by the area of the cross section of the pipe the distance from the service pipe under test back to the point of the leak is determined. In this way the location of an underground leak can be determined without the use of sound instruments or without excavating at random. This method has been used very successfully in the South Chicago district.

The dye test method was used in 45 sections and on some of these the test had to be repeated two or three times because of distributed leaks. In 25 of the 45 sections the leakage located amounted to 583,911 g.p.d. In 20 other sections 285,164 g.p.d. was located.

Motor Vehicle Operation by Water and Power Commissioners of Los Angeles.—According to the 27th annual report of the Board of Water and Power Commissioners of Los Angeles, Calif., for the fiscal year ending June 30 last, the board had a fleet of 512 motor vehicles, consisting of 175 trucks, 143 work cars and 194 automobiles. In addition there were 28 trailers and 18 pieces of equipment mounted on trucks, such as air compressors, hoists, pumps, electric welders and fuel tanks; also 152 pieces of construction equipment of various kinds used in the construction and operation of the works. The total mileage run by the fleet during the past year was 5,313,365 miles or 10,377.6 car miles. Trucks made a total of 1,362,912 miles, which is an average of 7,447.6 miles per truck, with the total miles run by the automobiles and work cars was 3,950,453 miles, which is equivalent to 11,253.5 miles per car. The average cost per car mile for the automobiles operated last year was 5.7 cts. and for the trucks 18.5 cts., as compared with a 6-year mean of 5.9 cts. and 18.8 cts. respectively. The total miles run this fiscal year exceeds last year by 564,946 miles.

Airport Survey in Michigan.—The League of Michigan Municipalities is undertaking an airport survey of the state for the purpose of ascertaining the number of airports, stages of development, method of financing, management and progress where development has been urged.

Water Works Records

How Detroit Keeps Records of Its Distribution System

By CLARENCE W. WRIGHT
Assistant Civil Engineer, Department of Water Supply, Detroit, Mich.

ONE of the purposes of the engineering bureau is to procure and preserve accurate records of all work done in connection with the distribution system. This system consists of all pipes used for the carrying of water from the pumping station to the streets or alleys adjoining each home or commercial enterprise. Orders to lay pipe are all numbered and divided into four classes, "A," "B," "C" and "D."

The "A" jobs are those recommended by the department and consists of the laying of mains above 16 in., replacements, the lowering of mains where necessary in streets to be paved or resurfaced, and mains laid to furnish better fire protection.

The Pipe Laying Budget.—At the time the annual budget is made up, a list is prepared of all mains 16 in. and larger which it is desired to lay during the following fiscal year. When the budget is finally approved, a revision of this list is made, based upon the amount of money available for large mains. This list is then submitted to the board for approval. Following this, plans and profiles are prepared, and the lines are laid as soon as practicable.

At the beginning of each year the department of public works publishes a list of streets and alleys it intends to pave or resurface during the following year. An investigation is immediately made to determine what work must be done in these streets during the coming year. It has been the policy of the department to replace all 4-in. mains with 8-in. or larger. As soon as notice is received of the intention of the department of public works to pave or resurface a street in which there is a 4-in. main, this main is immediately ordered killed and a larger main is ordered laid to replace it. The old mains are removed wherever convenient. Otherwise, the service connections are transferred to the new mains, the connections to other mains are cut off and the mains are abandoned. The depth of service mains in streets to be resurfaced is measured at each gate, or wherever opportunity affords. In case such mains are found to be so shallow that service connections are liable to freeze, the main is either lowered or replaced, or the service connections are lowered.

Work Preliminary to Paving.—Before paving contracts are let by the department of public works, photostat copies of the plans and profiles are sent to the department. Depths are taken by the maintenance division on all water pipes in the streets. The profiles are then returned to the engineering division and the pipes ordered lowered wherever the future grade of the street will give the pipe less than 4½ ft. of cover. It has been necessary to lower considerable pipe which was originally laid in territory outside the city limits, and which has since been annexed to the city. It is for this reason that the inspection of pipe laid outside the present corporate limits, but connected to the Detroit system, is so rigid. Grades are given on all pipe lines 24 in. and larger and wherever necessary on lowering jobs. The remainder of the pipe is laid on an even grade with a minimum cover of 5 ft. in paved streets and 6 ft. in unpaved streets. Street lines are located for the foreman wherever necessary, but this is required only in undeveloped subdivisions.

Much of the water pipe laid in the various sections before annexation to Detroit was of insufficient size and was placed in the alleys or easements. Hydrants could not be placed in locations which would provide adequate fire protection. These mains have therefore been replaced by larger pipes laid in the streets. These new mains have been ordered by forced petition by the Board of Water Commissioners.

All pipe laying jobs ordered upon petition are known as "B" jobs.

Laying Extensions.—If a man owns a lot located inside the city limits and desires water, he need only come to the office of the department of water supply, sign a petition requesting that pipe be laid to supply his lot, pay 75 ct. per foot of frontage served, and the department will, at its earliest convenience, lay a main past the front of his lot. This work is done under city ordinance. As soon as a petition is received, a plan is made showing the pipe it will be necessary to lay in order to supply the petitioner with water. This plan shows the size of pipe to be laid, the location in the street of the proposed line, and the location and size of all specials and gates. The scale used, 1 in. equals 100 ft., is sufficiently large to give this information since most extensions are made in the outlying districts.

A resolution is then passed by the board of water commissioners and the common council declaring the main necessary and ordering the work done.

An assessment roll is next prepared, assessing 75 ct. per foot of frontage against each lot which may obtain water from the new main. No charge is made where a main runs past the side of a lot, but acreage is assessed on all frontages.

An advertisement is published five times in a daily newspaper stating that the roll will be in the assessors' office for 12 days from date of the first publication.

The roll goes to the common council which either confirms it or orders it revised. If confirmed, the assessment becomes a lien against the property assessed and the roll goes to the city treasurer for collection.

The treasurer then advertises the roll in two newspapers once each week for three successive weeks, that the assessments are payable within 60 days from the first notice. Bills are also mailed to each person on the roll. If the assessment is not paid in 60 days, a penalty of 1 per cent per month is added for six months in addition to six per cent interest.

The real estate may then be sold for unpaid assessments in the same manner as in the case of sales for non-payment of general taxes.

After the water pipe is laid no owner is allowed to have a service until the assessment against his lot is paid.

Work Beyond City Limits.—The "C" jobs are beyond the city limits. If a subdivision or village outside of Detroit desires to lay mains in which Detroit water is to be furnished, they must first present a pipe layout for approval as to size of main and location of gate valves. When this is approved and an agreement is signed, and an inspection fee of 3½ct. per foot is paid, the contractor may begin work. An inspector is placed on the job who protects this department as to workmanship and depth of pipe.

All jobs where the cost of the work is billed to outside organizations are known as "D" jobs. This includes the changing of water mains for the construction of sewers, grade separations, etc.

Sketches are made in the field of all pipe laid, lowered or discontinued. Dietzgen's engineers' field book No. 400 is used for this purpose. Loose-leaf field books were tried for a time, the sheets being later bound, but it was found that sheets were either mislaid or destroyed, and valuable records were lost. It was also found that there was a tendency to merely make notes or temporary sketches in the field and to make the permanent sketches in the office. The final sketches so made were a little neater, but they were much more inaccurate and there was considerable danger on an engineer trusting to his memory to retain details. Frequently no sketches were made of small jobs because the sketchers had mixed these notes with notes of larger jobs.

By making his sketches on the job the engineer can see immediately what measurements are necessary, and he can get them at once. There is no danger of his forgetting such things as which way the pipe swings or where the swing begins and ends. Small matters, such as whether gates are in wells or boxes, are not missed. The engineer is required to check the measured length of the line against the foreman's pipe record, and to check the specials sketched against those shown on the pipe record. In this way many errors are eliminated as differences between the sketch and the pipe record can be checked by looking at the pipe in the ground. It has been the plan of the engineering bureau to have the sketch-

ers see all the pipe in the ground. This may mean that the sketcher will have to make several extra trips. He can, however, sketch the work as it progresses and thus avoid errors which would creep in were he to wait until the completion of the job before making any sketches.

Recording Pipe Lines, Etc.—The bureau keeps engineering records of pipe laid outside of the city but connected with the Detroit system, just as it does for its own pipe. This applies to villages receiving water from Detroit as well as to outlying subdivisions. All records of pipe laid are filed under north and south streets. Under each north and south street is further indexed all intersecting streets. Two important streets, Gratiot and Grand River Aves., which run at an angle with true north, are treated as north and south streets. Three sets of maps are used for recording pipe lines: intersection maps, section maps and distribution maps.

A map is made on tracing cloth of each street intersection, to a scale of 1 in. equals 16 ft. Alleys in which there are pipe lines are shown on the intersection of the street nearest. On these maps are shown all the details of the piping system. All locations are given from the property lines. Curbs are shown but sidewalks are not. Sewers, gas lines, conduits, etc., are shown wherever the water mains intersect them. These sheets are 20x21 in. and are bound loose-leaf fashion in sets of 20 to 40 sheets. This makes readily available all information regarding location and size of mains, gates, connections, etc.

Sectional Maps.—The sectional map of the city is drawn to a scale of 1 in. equals 300 ft. The sheets are 20x21 in. and are bound loose-leaf fashion. On this map is posted all distribution pipe. All gates, blow-offs and private sleeve and valve connections, hydrants and cisterns are also indicated. Solid lines only are used to indicate pipe lines, the width of the lines indicating approximately the size of the main. The sizes of all mains and many of their locations are also marked on them. The first of every year approximately 100 blue print copies are made and one copy is given to every foreman, leak investigator and tapper.

The city of Detroit and the surrounding territory is also shown on a map which is drawn to a scale of 1 in. equals 1,000 ft. This map is made up of 15 sections and is known as a distribution map. On it is shown all mains and gate valves and their sizes.

The sources of information as to the sizes of lots, widths of streets, names of subdivisions, etc., are the topographical maps, copies of recorded plats and real estate atlases.

The topographical maps are prepared by the city engineer's office and now cover the whole city. They are printed on cloth to a scale of 1 in. equals 200 ft.

Photostat copies of recorded plates are secured from the tract index office of Wayne County.

The increase in area of the city of Detroit has been 56.7 square miles in the last six years. During the same period the water system has grown from 1,647 miles to 3,401 miles, or an increase of 1,754 miles. This includes all areas furnished with Detroit water.

This increase in the volume of work has temporarily resulted in our permament records not being up-to-date. The relief from additional annexations within the last two years has lessened the demand for new mains and the engineering bureau is now in a position to make a gain in its permanent records.

Acknowledgment.—The foregoing is taken from a descriptive survey of the Department of Water Supply of Detroit, Mich., issued Oct. 1 by the Board of Water Commissioners.

Missouri Conference on Water Purification

The Missouri Conference on Water Purification held its fourth and most successful meeting at Hannibal, Nov. 15, 16 and 17. Interest in the program was evinced by the attendance of 75 members and guests and by the lively discussions which followed the presentation of all papers.

The Missouri Conference on Water Purification was organized by the State Board of Health for the purpose of providing an opportunity for those in charge of municipal water purification to become more closely affiliated and better qualified for their work. The hopes for the service which this organization could render in the production of safer municipal water supplies and better protection of the public health have been amply realized. Largely through the efforts of the organization, a marked improvement has been made in the operation of water purification plants in the state and an increased sense of responsibility has been developed among those in charge of the production of a commodity which is of the utmost importance to the public health.

Several changes were made in the constitution of the Conference. The name was changed to Missouri Water and Sewerage Conference in order to indicate that the present scope of interest included municipal sewerage as well as water systems. Provision was also made for affiliation of the Conference with the Federation of Sewage Works Associations.

The time and place of next year's meeting will be determined by the incoming Executive Committee. Following are the officers elected for the ensuing year:

Chairman—C. E. Heflin, Water Commissioner, Cameron, Mo.

Vice-Chairman—S. J. Duncan, Superintendent, Waterworks, Moberly, Mo.

Secretary-Treasurer—H. D. Peters, Assistant Engineer, State Board of Health of Missouri.

Executive Committee—W. V. Weir, Assistant Manager, St. Louis County Water Company, University City, Mo.; E. E. Wolfe, City Chemist, Hannibal, Mo.; W. P. Britain, Superintendent, Waterworks, West Plains, Mo.; J. N. Wells, Superintendent, Joplin Water Works Company, Joplin, Mo.

Index for A. S. T. M. Standards

The American Society for Testing materials, 1315 Spruce St., Philadelphia, Pa., has issued a pamphlet containing an index to all A. S. T. M. standards and tentative standards. The number of these standards and tentative standards has increased to such a degree (548 in all) that a complete index was deemed desirable and accordingly the present index was compiled in addition to the individual indexes appearing in the society's books of standards. The index will be a valuable aid in ascertaining whether the A. S. T. M. has prepared a specification or test covering a given material, and if so, its title and serial designation and where it is published in its lowest form. The index now becomes a permanent annual publication of the society.

Water Consumption in Los Angeles, Calif.—The mean water consumption in the city of Los Angeles, Calif., for the fiscal year ending June 30, 1928, was 323.3 second feet, of which 98.2 second feet was for irrigation purposes. The mean summer consumption was 428.8 second feet, of which 254.5 was domestic. The mean winter consumption was 221.9 second feet, 195.8 being domestic. The peak consumption was in July, 1927, the total being 542 second feet, of which 282 was domestic.

Traffic Survey for New York City.—New York City has engaged the services of Day & Zimmermann to make a survey of traffic congestion in the five boroughs of the city, including commuter traffic to New Jersey. It is intended that the studies made by private organizations, such as the Regional Plan of New York, and all data gathered by such city departments as police, and plant and structures shall be used. Rapid transit problems are not included in the traffic study.

County Parks Show Profit.—According to the report of the county park commission, parks in Westchester County, New York, made a profit for the county of approximately $175,000, and in addition created wealth for the county through assessed valuations amounting to $125,000,000 during the past year.

Municipal News and Water Works

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The Experimental Filtration Plant of Chicago, Ill.

What It Is and What It Is Doing

By JOHN R. BAYLIS

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The Department of Public Works of the city of Chicago, Ill., placed in operation last April an experimental filtration plant, which is probably the largest and best equipped installation ever constructed for studying water purification problems. The plant cost approximately $150,000 and the operating expenses will run around $35,000 annually. On the basis of the results obtained larger plants for handling the entire water supply will be designed. The accompanying interesting description of this plant and outline of the experiments now under way and contemplated were given in a paper presented Jan. 23 at the 44th annual meeting of the Illinois Society of Engineers.

WATER treatment has made such rapid advances within the past 30 years that some may wonder if there still remain unsolved problems justifying a city in making an expenditure of a quarter of a million dollars for research work on water purification. If we should gather together all the leading filtration engineers and filtration chemists to formulate a plan, based on current practice, for filtering Chicago's water, there would be nearly as many ideas on various details of the work as there are individuals. Many of these ideas would work; that is, water of a good quality could be produced, but some of the ideas would be more economical to construct or operate than others. It is not a question whether the water may or may not be purified, for we all know that it can be. The major problem is to find the cheapest and most efficient treatment for Chicago. In other words, the various opinions will be taken and tested under conditions that will give specific information as to their feasibility.

New Ideas to Be Tried.—No one need expect startling revelations, or the perfection of methods that will revolutionize water treatment, yet many new ideas will be tried, and out of this may come a few things that will be of aid in the production of purer and more palatable water. A very rigid standard of quality has been adopted as our aim and any treatment that does not produce water that comes up to the standard will be regarded as inferior. The water must be free from objectionable tastes and odors at all times, it must be safe bacterially by averaging not over one-tenth the number of B. coli allowed by the Government Standard for Drinking Water on Common Carriers, and the turbidity must average not over 0.2. It is hoped that the design and type of treatment to produce

these results will involve nothing unusual, especially as some of the better operated plants throughout the country are now equaling this standard and Chicago does not want a water inferior to that of other cities.

Opinions differ as to the merits of the several kinds of treatments that may be used and the different kinds of equipment found in the various filtration plants. In many instances there may be considerable modification of the design of a plant or a change in the method of treatment without affecting the quality of the water produced. For such cases economies of construction and operation should receive the greatest consideration. The efficiencies of the several treatments in common practice and the relative merits of the various kinds of equipment will be studied thoroughly. When it is understood that the experimental plant was constructed more for this purpose than to try to develop new methods of treatment, the reason for the elaborate layout becomes apparent. The experiments must be conducted in a manner that will leave no doubt as to the findings.

General Description of the Plant.—The experimental plant is housed in a frame building with stucco on the outside. The grounds around the plant have been graded and beautified, and this together with the attractive exterior of the building gives a very nice appearance. Being located in a fashionable residential section it is evident that the structure should be one that does not detract from the surroundings.

The main parts of the plant are constructed of reinforced concrete or steel, following to a large extent customary filtration practice in the materials used; that is, the main parts of the plant are constructed of materials as durable as though it was to be operated indefinitely. With the exception of a few small tanks, all basins and filters are constructed of reinforced concrete or steel. Division walls in the mixing basins and settling basins are of wood, but the wooden walls hold practically no head of water. It might be said that the mixing basins are of wood submerged in a concrete tank. This allows the use of light materials for construction, and being submerged, it is protected from decay. Considering labor

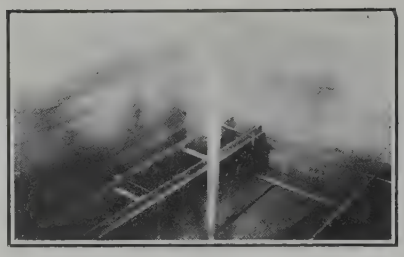


Fig. 2—Surface Wash in Filter No. 2

conditions in Chicago very little if any more will be expended on the structure by making most of it permanent than would have been necessary to keep wooden equipment in operating condition. It also gives a feeling that the experiments are being conducted under conditions so near actual practice that the results cannot be questioned. The layout of the plant is shown in Fig. 1.

The thought foremost in mind when designing the plant was to be able to conduct experiments with only one variable, that is, the variable would be the thing being tested. If rates of filtration are being tested, then every thing else should be the same, except the rates of filtration. The water should be all the same through every process until it reaches the filters, where it will divide and go to the several filter units set to operate at various rates. The range of filtration rates desired is obtained by having a number of units operating at the same time rather than operating one or two units over a period of time at certain rates and then changing the rates over another period of time. This method of conducting experiments will be followed for tests on the size of sand, kind of sand, depth of sand, time of mixing, time of settling, and probably other tests.

The main features of the plant may be summarized as follows:

1. A balancing tank for keeping a uniform head of raw water on the control valves.

2. Four chemical solution tanks and one dry feed machine. With this equipment three kinds of chemicals may be handled at the same time.

3. Three mixing basins. One where the flow is through horizontal conduits, one where the flow is through vertical conduits, and mechanical agitation.

4. Four settling basins, which will be operated usually as two basins with two compartments each.

5. One small settling tank with five compartments.

6. Twelve filters. Two of the filters have a sand surface area of 100 sq. ft. each and the other ten have a sand surface of 10 sq. ft. each.

7. Two clear water reservoirs.

8. One wash water tank.

9. Two wash water pumps.

10. Carbon dioxide generating plant.

11. Two chlorinating machines.

12. Chemical laboratory.

13. Bacteriological laboratory.

Mixing Basins.—It was thought best to construct three kinds of mixing basins, but when one considers the various kinds of experiments that are to be conducted and the variations necessary in the flow of water, it becomes evident that the mechanical mixing basin will have to be used for most of the experiments. Every time the rate of flow is changed in channels or baffled basins it produces a change in the agitation of the water, whereas the violence of the agitation in the mechanical mixing basin is independent of the rate of flow through the basin. It is true the water passes through in a shorter time when the rate is high, but with eight points where the water may be taken off it need not pass through the entire basin when the flow is low. The mechanical basin is divided so that one-half of it may be used for one treatment and the other half for another treatment. Interchangeable gears allow the speed of the stirrers to be varied over quite a wide range.

The horizontal and vertical mixing basins are made to give a water velocity about equal to that of customary practice in horizontal baffled basins and in over-and-under basins. These basins will be compared with the mechanical basin, and will be used for a few experiments. Because filtered water is being given away, there will be times when one of these basins will be used for treating a supply of drinking water while the mechanical basin is being used for an experiment where the quality of the water for drinking purposes may be in doubt, otherwise they will be used only for certain specific experiments. One of the worst things that

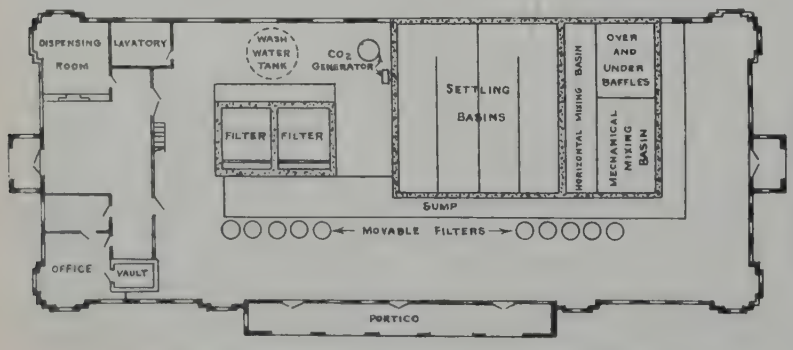


Fig. 1—Plan of Experimental Filtration Plant of the City of Chicago

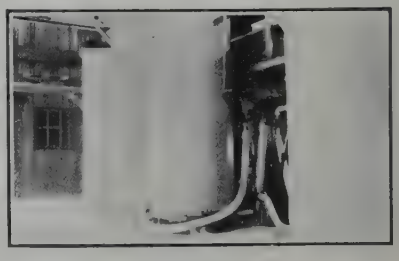


Fig. 3—Small Filter Mounted on Movable Platforms

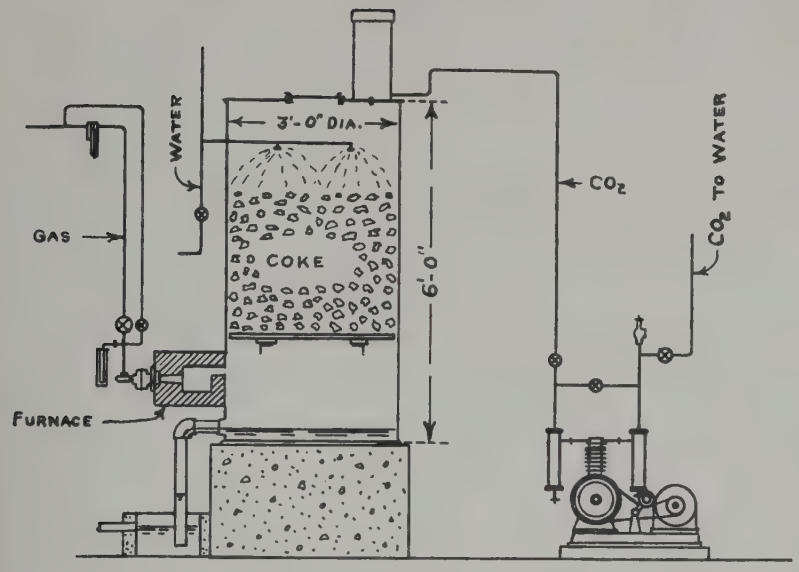


Fig. 4—Carbon Dioxide Plant

might occur in its effect upon the public would be to give away water that was not satisfactory in every respect, and chances cannot be taken with the drinking water. If only experiments that produced an excellent quality of water were conducted the desired information might not be gained, for it is important to know just how much a treatment may be varied without affecting the quality of the water and it is necessary to extend a few experiments to the point where satisfactory water is not produced.

The horizontal basin is a series of horizontal conduits, 50 altogether, about 10 in. square and 30 ft. in length. This is 1,500 ft. of conduit. With a velocity of 1 ft. per second it will take the water 25 minutes to pass through the entire mixing basin. For this velocity each return of the water to one end requires 1 minute and with the same velocity the full volume of the water may be taken off after running in the conduits 1, 3, 5, 10, 15, 20 and 25 minutes. Take-offs for the small filters are provided at 1, 2, 3, 4, 5, 7, 10, 12, 15, 17, 20, 22 and 25 minutes mixing when the velocity is as stated. Changing the velocity will of course change the time of mixing for the take-offs, but there are a sufficient number to give the desired information on any kind of an experiment that may be conducted.

The vertical conduits, or over-and-under basin, are very much like the horizontal basin, except that the flow is upward and downward and there are more turns. There are 81 conduits, 12 in. square, and 11 ft. 3 in. long, making a total length of 911 ft. This provides for about 15.2 minutes mixing at a velocity of 1 ft. per second. Due to the large number of turns in the basin it was thought that a velocity slightly less than 1 ft. per second would do the same work as a velocity of this amount in the horizontal conduits, and this is one of the reasons for making the conduits with a little larger area than for the other basin. There also are a few less take-offs provided, but the number is great enough for any kind of experiment that may be performed. With a liberal supply of overflows and take-offs the water velocity through any part of the plant can be regulated to any desired figure. Comparing the horizontal basin with the vertical basin at a velocity of 1 ft. per second in the conduits, the take-off on the horizontal conduits at the 15-minute point is opened and the one at the same point on the vertical basin is also opened. This will mean that more water passes through the vertical conduit basin, but the excess can go to waste so that the settling basins and filters may handle the same amount of water.

Experiments having most any violence of agitation and time of mixing may be conducted with one of the three mixing basins. From this we hope to formulate some idea as to the best type of mixing basin and time of mixing for the large plant, but bearing in mind that small basins may not give an exact duplication of larger ones. To get the same violence of agitation as is produced in a large basin a certain velocity must be maintained; that is, reducing the scale of a large basin one one-hundredth or more will not answer the purpose, for the violence of the agitation would be changed to the extent of materially affecting the results. Reducing the scale, but maintaining the violence of agitation with the stirrers in the mechanical basin probably will give the same results as a large basin, and it is this type of basin that we are relying on for most of the experiments where the mixing might have an influence.

Settling Basins.—There are four settling basins, or it might be said that there are two basins with two compartments each. The compartments are 7 ft. wide, 30 ft. long, 12 ft. deep at one end and 10.5 ft. deep at the other end. It is not expected that a great deal will be learned about the design of large settling basins from these small ones, but the desired degree of settling can be determined. Careful measurements of the suspended matter settled from the water are being made; in fact, the volume of coagulated matter is measured on the water as it goes to the basins and as it leaves. Occasional tests will be made at points throughout the basins. If it is found desirable to settle out 90 per cent of the coagulated matter from the mixing basin water, or it is desired to settle

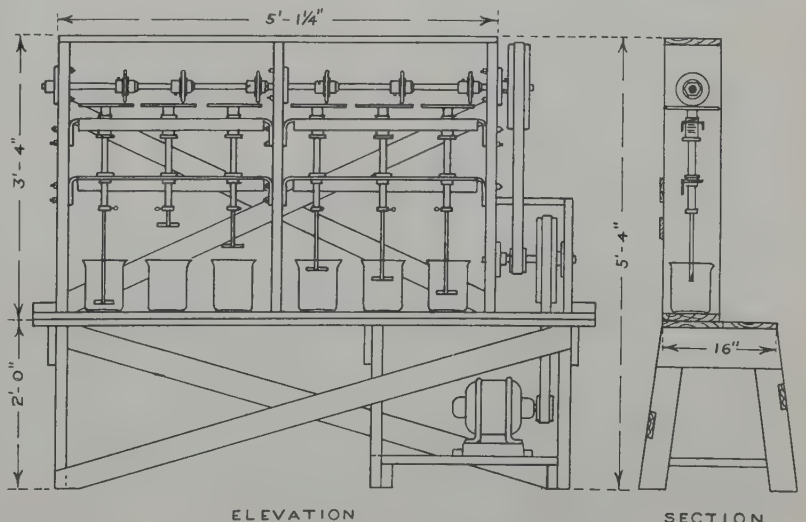


Fig. 5—Laboratory Stirring Machine

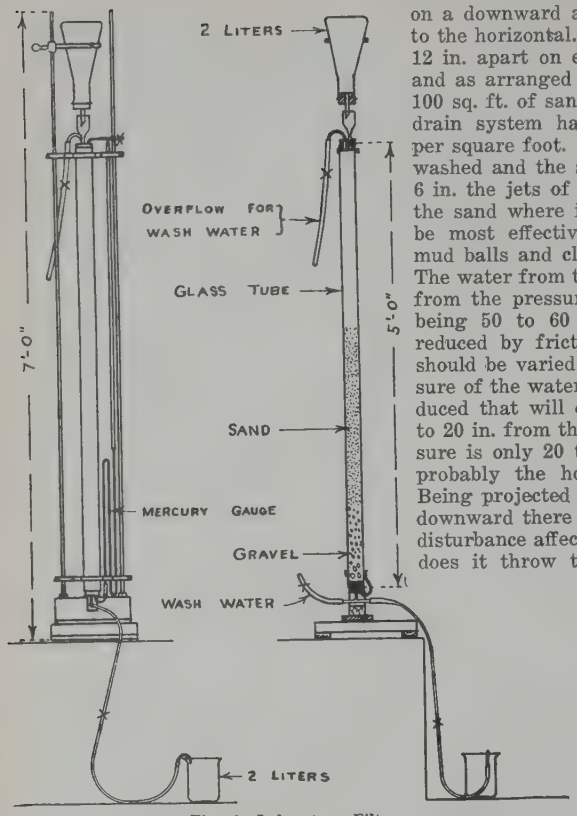


Fig. 6—Laboratory Filter

to a definite amount of coagulated matter before the water goes to the filters, more reliance will have to be placed on what is being accomplished in the large settling basins throughout the country than the results obtained in such small basins. What should be accomplish by sedimentation can be determined fairly accurately, and this will be of great aid in determining the size and shape of the large basins.

Filters.—The design of the larger filters is in accordance with standard practice. They are constructed of reinforced concrete and are similar to a large number of filters of this size throughout the country in that there is a bed of sand 24 in. thick, 13 in. of graded gravel, a system of underdrains, and filter rate controllers. The underdrain system at present is perforated pipe, 2 in. in diameter, spaced 12 in. apart on centers, and having 11/32-in. holes spaced 6 in. on centers. It is planned to remove these underdrains later and test other types. One of the filters has a marble operating table and hydraulic valves, whereas the valves on the other one are hand operated. Both filters have gauges that record and indicate both the rate flow and loss of head.

Surface Wash.—The only thing unusual about the filters is the surface wash. This is a system of ¾-in. pipes spaced 20 in. apart and located about 1 in. above the sand. The pipes have 3/16-in. holes to project jets of water on a downward angle at about 30 deg. to the horizontal. The holes are spaced 12 in. apart on each side of the pipes, and as arranged there are 96 holes for 100 sq. ft. of sand surface. The underdrain system has two 11/32-in. holes per square foot. When a filter is being washed and the sand is suspended 4 to 6 in. the jets of water are thrown into the sand where it is believed they will be most effective in breaking up the mud balls and clogged masses of sand. The water from the surface wash comes from the pressure mains, the pressure being 50 to 60 lb., but it is greatly reduced by friction losses. The holes should be varied according to the pressure of the water. A jet should be produced that will cause a disturbance 15 to 20 in. from the pipe, and if the pressure is only 20 to 25 lb. the pipes and probably the holes should be larger. Being projected at an angle of 30 deg. downward there is no possibility of the disturbance affecting the gravel, neither does it throw the sand upward more than the usual wash when as much water is being applied beneath the bed as the total amount used.

Wash water is now being applied underneath the beds in the usual manner at a rate of 19 in. vertical rise per minute and through the surface wash at the rate of 5 in. vertical rise, consequently the total wash water used is the same as if 24 in. vertical rise was being applied only underneath the beds as is customary practice. No additional water is used, but about one-fifth of it is being applied through the upper system of piping at a higher pressure than that applied beneath the bed. The upper or surface wash is turned on at the same time or in advance of the regular wash and is cut off about one-fourth minute in advance of the regular wash so that the bed will settle to a smooth uniform surface. The gentle disturbance produced in the ordinary wash is not sufficient to prevent the formation of mud balls and clogged places for many of the waters now being filtered. The surface wash will not break up clogged areas that are resting on the gravel as all large clogged areas do, but it will keep the sand so clean that the clogged areas will not start.

Most mud balls remain on or near the surface of the sand and do not greatly affect the filter beds except that sand frequently becomes embedded in the mud, causing it to sink to the gravel. This frequently starts the formation of clogged areas. Mud balls on the surface may materially affect certain kinds of experiments and it is necessary that the sand be kept clean and the surface smooth. Scraping the surface would remove some of the fine sand that is usually near the surface and would be correcting a bad condition only to allow it to get bad again, consequently it seems that some such washing device is almost an essential. Fig. 2 shows the sand surface to be free from mud balls, or clogged areas which usually occur along the side walls first. This bed had been in operation about eight months. The Lake Michigan water is not one that causes the filter beds to clog badly and this does not prove that the surface wash would keep filter beds in good condition elsewhere, yet it is believed that it will if properly installed and properly operated. The proportion of water to be applied through the surface wash may need to be greater than one-fifth where the beds clog badly.

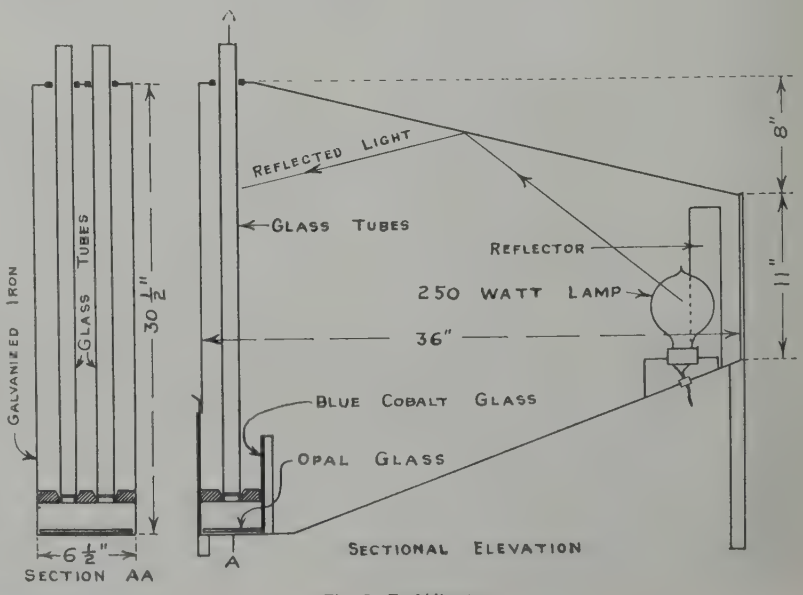


Fig. 7—Turbidimeter

Small Filters.—The small filters, which have 10 sq. ft. area each, are constructed of steel. They are set on platforms so that they may be moved from one location to another with a Barrett lift truck. The filters are provided with hose connections so that changes in the set-up may be made by the operators without having to change any piping. Some of the hose may be seen in Fig. 3, which shows several of the small filters. Where frequent changes have to be made, and union rules do not permit filter operators to do piping work, the wisdom of using hosing connections becomes apparent. There has been less than one day of work for a plumber since the plant was constructed, yet the small filters have been moved about considerably since starting operation.

The rate of flow through the small filters is set by hand, the rate being adjusted every hour. Fairly uniform control is obtained in this manner, more uniform than may be expected. Each filter has two meters, one a venturi for use in setting the rate and the other an ordinary service meter for keeping a record of the amount filtered. It is true that such an arrangement requires constant watching, but additional help is not required when the filters are being run. Having 10 units of this size hastens the completion of the experimental work, and as has been stated enables experiments to be conducted with a greater degree of accuracy than would be the case with fewer units.

Carbon Dioxide Plant.—The CO_2 used for recarbonating the water, when the treatment leaves it more alkaline than it should be for domestic uses, is obtained by burning city gas. This is not the cheapest way of producing CO_2, but it gives a constant flow which is of great importance in experimental work. The CO_2 apparatus, except the compressor, was furnished by the Flinn & Dreffein Co. This is shown in Fig. 4.

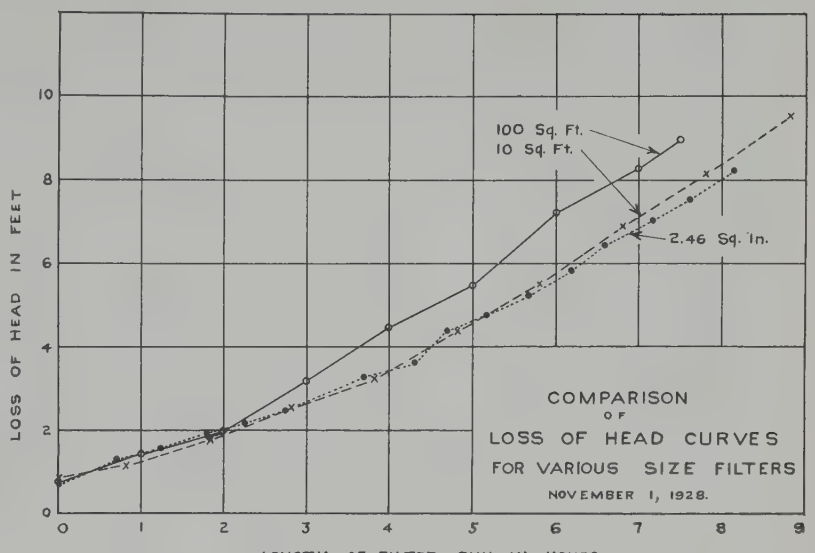


Fig. 9—Loss of Head Curves

The plant has a capacity of about 2 lb. of CO_2 per hour, which is sufficient for experiments using lime and iron. It is not enough, however, to recarbonate water to maintain a flow of 2 gal. per square foot per minute for one of the larger filters when the excess lime treatment is used. Having the smaller units the larger filters can be cut out and experiments using most any rate of filtration may be conducted with the present equipment. Should the work indicate that the excess lime treatment needs investigating more thoroughly the supply of CO_2 will be increased. It may be found cheaper to purchase the excess over the plant capacity in cylinders than to increase the capacity of the plant. It would be only a few experiments where it would be necessary to run the large filters.

The diffuser piping is a grid made of ¾-in. pipe, 6 ft. by 6.5 ft., with pipes spaced 2 ft. apart. The holes are 1/16 in. in diameter, point downward, and are spaced 6 in. apart along the pipes. This makes a total of 48 holes. The grid is connected by rubber hose to the supply line and may be suspended at any depth at any point in any of the settling basins. It is easily moved from one location to another without disconnecting the piping.

In giving this description of the plant no effort has been made to describe all of it in detail. It is only where the design is unusual or different from that of prevailing practice that detail descriptions are given. There are many things so near what may be found elsewhere that details should not be necessary. To illustrate: There are two chlorinating machines. They are Wallace and Tiernan machines just like those in many plants throughout the country. This applies to the chemical feeding equipment and to other parts of the plant.

Method of Conducting Experiments.—The method of conducting the experiments has been partially explained with the description, however, certain subjects will be discussed more fully. It is not intended to give the results of what is being found, for the paper is already too long for presentation in the time allotted. The work has been divided into 44 subjects, but the outline may be changed somewhat as the work progresses. Work is under way on the 23 subjects marked with an asterisk (*).

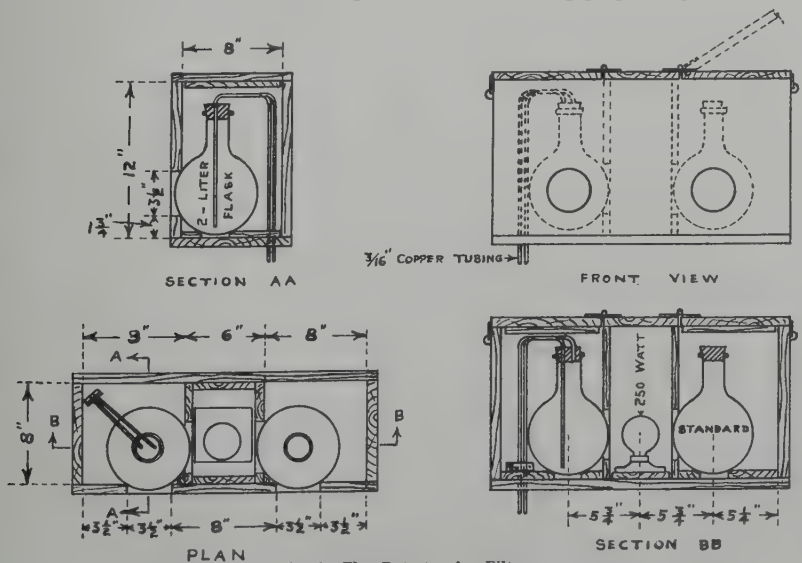


Fig. 8—Floc Detector for Filters

Outline of Experimental Work

1. Chemical Treatment.
   a. *Aluminum sulfate.
   b. *Ferrous sulfate and lime.
   c. Chlorinated iron.
   d. *Excess lime treatment.
   e. Lime and soda ash.
   f. Sodium aluminate.
   g. *Recarbonation.

2. Mixing Basins.
   a. Types of basins.
   b. *Time of mixing.
   c. *Violence of agitation.

3. Settling Basins.
   a. Size and type of basins.
   b. *Rate of settling produced by various treatments.
   c. Sludge removal.

4. Filters.
   a. *Rates of filtration.
   b. Size of sand.
   c. Kind of sand.
   d. Depth of sand.
   e. Gravel.
   f. Underdrains.
   g. Controlling apparatus.
   h. *Washing.
   i. *Surface wash.
   j. Air-binding of filter beds.
   k. Causes for clogging.
   l. Reverse flow agitation in lieu of washing during periods of short filter runs.

5. Chlorination.
   a. Prechlorination as an aid in chemical treatment.
   b. *Prechlorination as an aid in lengthening filter runs.
   c. Prechlorination as an aid in keeping the sand beds in good condition.
   d. Chlorine required to make the water safe bacterially.

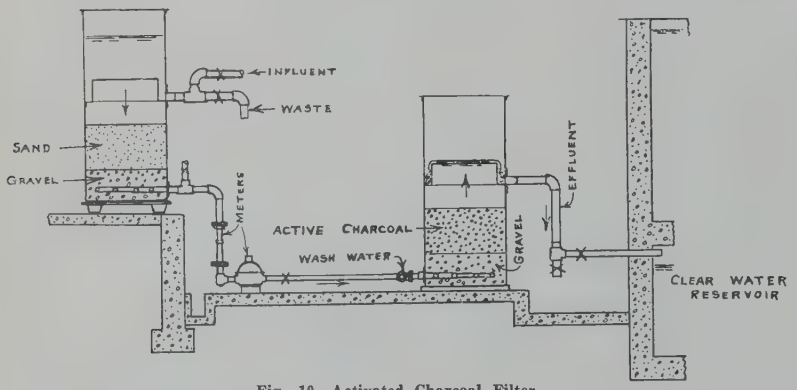


Fig. 10—Activated Charcoal Filter

6. Removal of Tastes and Odors.
   a. *Removal of phenol by excess chlorination.
   b. Removal of other tastes and odors by excess chlorination.
   c. *Activated carbon for the removal of phenols and other taste producing substances.
   d. *Activated carbon for dechlorinating water treated with an excess of chlorine.

7. Filtration Without Chemical Treatment.
   a. *Slow sand filtration.
   b. Rapid fine sand filtration.
   c. *Rapid coarse sand filtration.
   d. *Methods of filtration frequently used for industrial purposes.

8. Miscellaneous Items.
   a. *Duplication of plant results in the laboratory.
   b. *Measurement of the volume of coagulated matter.
   c. *Methods of testing for phenols.
   d. *Microscopical counts.
   e. *Effect of the size of unit on filtration results.
   f. *Special equipment and devices.
   g. Effect of certain trade wastes on filtration.

The Laboratory Part.—No description of the experiments being conducted would be complete without relating the part the laboratory plays in the work. Many of the problems are attacked first in the laboratory and then in the plant. It is possible to conduct experiments in the laboratory at a much less cost than they can be conducted in the plant. Not only this, but conditions can be varied greatly beyond the ranges of what may be accomplished in a plant, and this is frequently of great value in the interpretation of results or in obtaining specific proof of some point. The idea has prevailed heretofore that very little could be learned from laboratory as to the performance of a filtration plant. This has been due to the lack of the right kind of equipment and a knowledge of how to conduct the experiments. For our work, use is made of several pieces of equipment not found so extensively in water purification laboratories. The equipment consists of a stirring machine (Fig. 5), laboratory sand filter (Fig. 6) (centrifuge with 100-cc. tubes), turbidimeter (Fig. 7), and floc detector (Fig. 8).

With this equipment the water may be treated and filtered in such a way as to give very accurate duplication of plant results. To show that the laboratory filter will give duplication of larger filters, one of them has been set up in the plant and operated under the same conditions as the larger filters. Fig. 9 shows loss of head curves for filters having areas of 100 sq. ft., 10 sq. ft. and 2.46 sq. in., the smaller one being the laboratory filter. Every condition was the same, except the sand bed area, that is, the same water branched and went to the three units. The sand was the same depth and size, in fact it was all from the same pile of sand. The filters were operated under the same hydraulic conditions in that part of the head was positive and part negative, and the rates per square foot were the same.

It is not expected that two filters of the same area will give loss of head curves that coincide more closely. First one unit and then the other may show slightly longer or slightly shorter runs. The bacterial results average very closely for the three size units, just as closely as one would expect three filters of the same size to average. This also applied to the turbidity removal. In other words, the small laboratory filters and the small plant filters give the same results as the largest units. This fact greatly facilitates the work. Most of the time there are three to ten experiments under way in the plant and the laboratory.

Flexiblity of Plant.—To illustrate the importance of flexibility in the experimental plant, double filtration was not contemplated when the plant was constructed. There was no difficulty, however, in making the set-up as shown in Fig. 10 for testing activated carbons. In this case it is essential to have water going through the carbon bed.

The experimental work quickly demonstrated that handling the microorganisms so as to produce filter runs long enough for the practical operation of a large plant was going to be our major problem. For a period of six to eight months the lake water contains such an abundance of certain microorganisms that it would be difficult to operate when aluminum sulfate is used to coagulate the water. Ordinarily there is not enough turbidity in the water to materially aid in settling out the coagulated matter before it reaches the filters and a large percentage of the organisms go on to the beds. In some localities it is possible to kill the microorganisms and settle most of them out in large storage reservoirs, but it is evident that the microorganisms cannot be controlled in Lake Michigan. The water must be taken as it is and the trouble handled in some other manner.

It is not the purpose of this paper to give results of the experiments, but one or two things may be mentioned. The work to date indicates quite conclusively that some treatment other than aluminum sulfate will have to be used at least part of the time. This is a fact of major importance and it is doubtful if any designing engineer would provide for the use of a coagulant other than aluminum sulfate in the absence of the experimental work. This alone more than justifies the total expenditure for our work. The experiments also indicate quite conclusively that filtration rates greater than 125,000,000 gal. per acre per day may be used, another fact which, if confirmed by future experiments, will result in saving much more than the total cost of the experimental work.

There are many things relating to apparatus and to patented devices that need investigating. In the absence of definite figures a clever salesman may persuade the engineer to include something in the design not entirely suited for the work it has to do. The writer is aware of seven types of dry feed machines for feeding chemicals into the water, most of which are being actively promoted. The engineer has no information as to the relative merits of dry or solution feeds. There are five or six types of filter rate controllers, several of which are being actively promoted. A number of different kinds of filter bottoms and filter under drains have been used with not much information as to their relative merits. There are advocates of slow sand filtration and there are those who believe that this

kind or that kind of treatment should be used. It is admitted that a few of the experiments are being conducted primarily to keep the designers of the large plant from being annoyed unduely by the advocates of certain devices or equipment. Some promoters do not hesitate to take the fight over the engineer's head and it is well that he be fortified with facts.

It is hoped that these remarks will give a clearer insight as to the magnitude of the problem and to the importance of conducting experiments under conditions that give accurate and reliable information.

The writer wishes to express his appreciation of the courtesies being shown him in the work by Richard W. Wolfe, Commissioner of Public Works; Loran D. Gayton, City Engineer; and Henry A. Allen, Mechanical Engineer, in charge of the Operating Division of the Bureau of Engineering.

When the Experts Were Dismissed

An Inefficiently Operated Sewage Treatment Plant

By CHARLES CARROLL BROWN
Associate Editor Municipal News and Water Works

SOME years ago visits were made at intervals to sewage treatment plants in a city using Imhoff tanks which had the benefit of good engineering design, one at least of advice from Karl Imhoff. They also had the advantage of expert superintendents of operation and of the research conducted by them, so that the plants were pointed to by other cities as examples worth following. They had their troubles from time to time and some history was made and published, making known the methods used in overcoming these difficulties which were stepping stones in the advance of knowledge of a subject which is not yet too well known.

But changes in administration and increase in liberality of expenditures followed by drastic curtailing of appropriations, led to dismissal of experts and reduction of forces until a brief examination recently showed the results of neglect, lack of knowledge of proper methods of operation, inability to make the research necessary to keep up with the growth of the city and the constant tendency toward overloading the plant, and the lack of men enough to keep the plant in good clean operating condition.

When the plants were built, early in the history of the Imhoff tank in this country, they were located outside the city in the bottoms of the valleys of the creeks whose watersheds they serve, and the surrounding hills were forest or farm land, beautiful as scenery and highly eligible for first class city and suburban developments in estates and subdivisions.

Real Estate Development Around the Plant.—The good condition of the sewage treatment plants and consequent freedom from odors and other unpleasant features, evidently did not discourage the fine developments referred to, for now the hilltops are dotted with large estates, fine mansions and large institutions almost all round the horizon, and the better class of subdivisions, made beautiful by the best exercise of the city planners and landscape architects are crowding closer each year to the city property on which the plants are located, not only on the side next the city but around the area both ways.

Recently there have been complaints of odor nuisances and demands for their abatement, and some rather futile attempts at cleaning up are under way.

The city is far enough south to insure that the purification of the sewage on its way through the plant can continue throughout the year with little retardation from the action of cold weather, and it would seem to be easy to apply some of the modern methods of handling such treatment plants with a minimum of odors if not with practical freedom therefrom. Some of these methods were developed in these plants.

Present Condition of the Plant.—One of the plants was visited on a day so rainy in the morning that work on the plant was stopped before noon and only a negro watchman was on duty. The work on hand was a washing of all the stone in the filter beds and the effluent from the Imhoff tanks was discharging directly into an outlet ditch and thence into the creek. While there was a fair amount of dilution by the creek, enlarged by recent rains, the stream for the observed mile or so below the plant was of nearly the same color as the effluent from the plant, but under the drenching rain had no appreciable odor, although the influent of the plant had a noticeable odor of slightly stale sewage. Less favorable conditions of dilution of sewage and absorption of gases by the falling rain might well give rise to complaints from the neighbors of objectionable odors.

Checks on Operating Steps Lacking.—Observation of the tanks showed that, with the exception of one or two of them, the water surfaces of the flow-through chambers were kept clear, but nearly all the gas-chambers were foaming and overflowing into the flow-through chambers. Part of the gas chambers were provided with iron hoods to collect the gas, but the hoods and the connecting pipe were not maintained in good condition and much gas was leaking out of hoods and pipe as well as bubbling out of the water around the submerged edges of the hoods. This may have been due to the gas not being burned, at least when work is stopped on the plant. There were some indications that a considerable source of odors might be the sludge, drawn too frequently and so not completely decomposed and rendered practically odorless. The question then arises as to whether the plant is overloaded or is inefficiently operated. The inspection was brief and considerable time would be necessary to answer this question. Disuse of laboratory showed lack of checks on the steps in the operation of the plant, which might indicate the probable sources of the troubles.

This visit would not have been reported except for the facts stated as to its former good condition and its present poor condition and the rather evident inability of the present operators to determine the sources of the trouble and to apply tested methods of manipulation and treatment. It is the largest plant visited in the past two years which showed markedly poor results and suggests that there may be others of similar size which are in like condition. The weather conditions in the South are so much more favorable for efficient sewage treatment that there is much less excuse for an odorous plant than farther north, where artificial heat is sometimes used to supply the deficiencies of the winter climate and keep the processes of purification in efficient operation throughout the year.

The city referred to is nameless here, as some other city under like conditions of neglect of sanitary matters from political reasons or mistaken economy might well have happened to receive the visit during a like period of trouble from similar abandonment of the principles and necessities of efficient operation.

New York State Street and Road Contractors to Meet

The street and road construction industry of New York State will gather at the Hotel Syracuse, Syracuse, N. Y., March 13 and 14, in connection with the third annual convention of the New York State Highway Chapter of the Associated General Contractors of America. It is expected the state-wide gathering of this industry will attract hundreds of contractors from all sections of New York State. What is of interest to contractors is likewise of interest to material producers, equipment manufacturers, bonding interests, city and county officials, state and city engineers and all others allied with the industry.

The meetings will be held on the afternoon and evening of March 13, and on the morning and afternoon of the 14th. The banquet will be held in the Grand Ballroom of the Syracuse Hotel at 7 o'clock, Thursday evening, March 14. The banquet will be a friendly get-together with an elaborate entertainment furnished by the associate members of the organization and advertisers in its magazine.

Business Frontage and Its Relation to Population in Chicago Region

How much business property to plat in subdivisions and to zone for commercial use is the outstanding question always before the subdivider and the zoning authorities.

The Chicago Regional Planning Association believes that there is a definite relationship between population and the amount of business property actually in use. To find what that relationship is, measurements were made in 43 cities and villages in the Region of Chicago to determine the facts. Thirty-three of the communities measured were medium sized suburbs both residential and industrial, in varying directions and distances from Chicago. Ten larger cities were added, Evanston, a residential city directly adjoining Chicago, Kenosha, Chicago Heights, East Chicago, Aurora, Elgin, Joliet, Gary, Michigan City and Hammond, industrial communities from 29 to 57 miles away.

These measurements were made over a period of more than two years, 19 communities having been measured in the summer and fall of 1926, and the remainder in 1927 and 1928.

The 19 cities measured in 1926 were remeasured in 1928 and show substantially the same average.

At each place exact measurements were made of the ground floor store frontage actually in use and the number of stores was recorded in fifteen main classifications. Municipal and federal buildings were omitted. The population is an estimate from the most reliable sources.

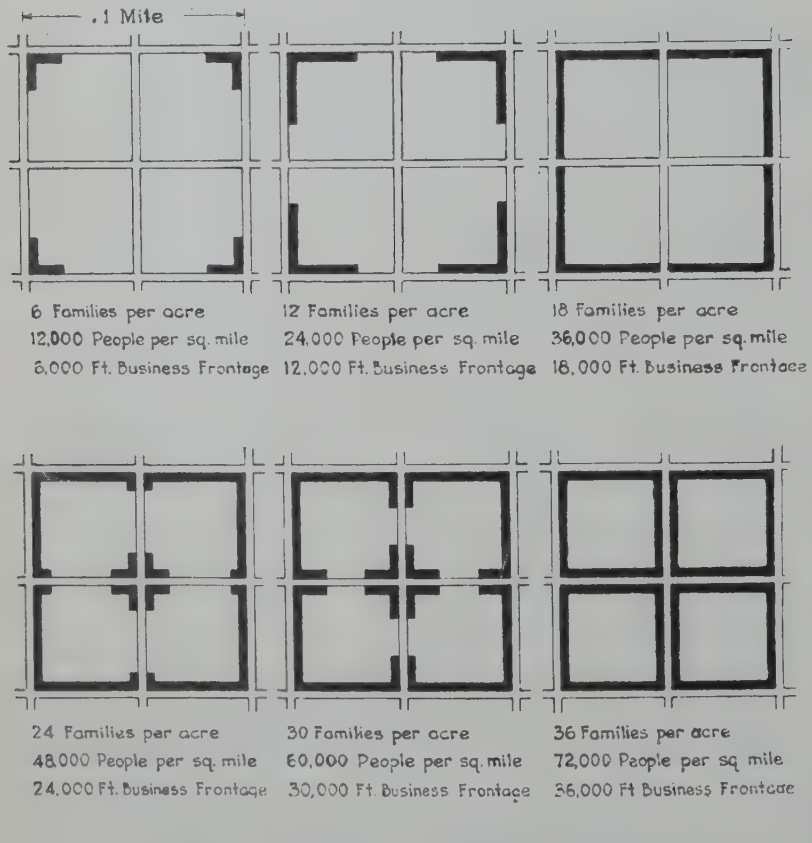
Conclusions.—Approximately 50 ft. of business property are in use by every 100 people in the 43 cities and villages measured.

The character of the community (industrial or residential) has little effect on the amount of business frontage in use.

The size of the community makes little or no difference in the relation between population and business frontage.

Generally, the community which lies a greater distance from Chicago, in miles and minutes, has a larger amount of business frontage per 100 people. This is because the business frontage serves a population outside its corporate limits which is not represented in our population figures.

Recommendation. — The Chicago Regional Planning Association recommends that subdividers and zoning authorities adopt the figure 50 front feet of business for each 100 expected population as a basis on which to estimate the needed business property in subdivision plats and in zoning ordinances.


RETAIL BUSINESS FRONTAGE
REQUIRED FOR VARYING POPULATION DENSITIES
ON ONE SQUARE MILE
Av. Number People per Family = 4.4+
Av. Business Frontage Per Capita = 0.513 Ft.
(based on actual measurements in 43 Municipalities of the Region of Chicago)
Total Acreage 640 Ac
Acreage in Streets 189 Ac
Acreage for Building 451 Ac
Business Frontage
.1 Mile
6 Families per acre
12,000 People per sq. mile
6,000 Ft. Business Frontage
12 Families per acre
24,000 People per sq. mile
12,000 Ft. Business Frontage
18 Families per acre
36,000 People per sq. mile
18,000 Ft. Business Frontage
24 Families per acre
48,000 People per sq. mile
24,000 Ft. Business Frontage
30 Families per acre
60,000 People per sq. mile
30,000 Ft. Business Frontage
36 Families per acre
72,000 People per sq. mile
36,000 Ft Business Frontage
CHICAGO REGIONAL PLANNING ASSOCIATION
Burnham Bldg Chicago
Retail Business Frontage Required for Varying Population Densities on 1 Square Mile

Convention of Illinois Water Well Drillers

The convention of the Illinois Water Well Drillers Association, held Feb. 12 and 13 at Urbana, Ill., was attended by practically 100 water well drillers and contractors located throughout the state. Some very interesting papers were read by contractors, engineers and members of the State Geological Survey and the United States Geological Survey. Practical talks were given on how to satisfactorily and economically perform practically all details of drilling and completing wells of all sizes, from small farm wells up to 200 ft. in depth to large municipal water works plants, where the wells would run in price from $15,000 to $30,000 each, and where the work would consist of constructing the entire plant such as well, pumping equipment of all sizes, pump house and reservoir and pipe lines.

The officers elected for the year 1929 are:

Chas. S. Cumming, President, Gardner, Ill.; B. L. Palmer, Vice-President, Aurora, Ill.; S. G. Geiger, Secretary, Chicago, Ill.; C. F. Steigman, Treasurer, Paxton, Ill.; Guy W. Peterson, Director for three years, Rockford, Ill.; Mike Ebert, Director for two years, Washington, Ill.; H. Meister, Director for one year, Tuscola, Ill.

The Convention for 1930 will be held in February of that year at Urbana, Ill.

Some Important Features of Sewage Disposal

A General Discussion of Matters Needing Consideration

By WYNKOOP KIERSTED
Consulting Engineer, 614 Interstate Bldg., Kansas City, Mo.

THE question arises whether we are progressing as well as we may and whether we are devoting our efforts along the right lines in the matter of sewage disposal. As our cities develop industrially, socially and intellectually we find new conditions arising which demand our best thought to meet them in the most satisfactory and economical way. The standards of living have been raised continually, and accordingly there is an increasing demand for more that contributes to social and intellecual welfare. Things that were once regarded as luxuries have become a necessary contribution to our daily wants and comforts. Among these changes there has been a great growth of civic pride and enterprise which exhibits itself in various ways as in the construction of beautiful buildings, the provision of parks, boulevards, recreational facilities of various kinds, assembly halls, and numerous other improvements which render a city beautiful, attractive and healthful. While there is much in geographical location to stimulate industrial development and urban growth still quite as much depends upon the enterprise and energy of the citizens. There is always a desire of every town to give prominence to some distinctive feature it possesses, either a natural resource, some special industrial development, unique public works, salubrious climate, but there is one thing that all aspire to, and that is clean and healthful surroundings.

Two Important Utilities.—Probably none of the other urban utilities contribute more to the comfort, economy and safety of civic life than a wholesome public water supply and water-carriage sewage. The two are linked together in too close relation to be successfully separated. The wholesome water entering the household or industrial works comes out grossly soiled and polluted, entirely unsuited to be retained upon the premises because of its putrescibility. It must be provided with facilities for a complete and steady outflow which can be utilized with a minimum of effort and a maximum of economy. This quick, effective and economical removal of putrescible household waste has engaged jointly the most intelligent effort of the ablest sanitarians and the best manufacturers of sanitary ware for many years and has culminated in the present-day water-carriage system of sewage and house drainage. Everything putrescrible and readily conveyed by water passes out of the household, out of the neighborhood and away from the community through well ventilated, securely jointed, impervious, closed conduits in the briefest possible period of time. The system is so simple of design, so provided with self-contained mechanical appliances of which no household tenant can mistake the proper manipulation and in its entirety so self-contained as to require the little operating attention needed in preventing obstructions by articles surreptitiously thrown into the street sewers. It is the common desire of the entire community that there shall be no interference with the service which the sewers afford and that such inspection be given the operation of the system as a whole, as to prevent any interruption of service. Any individual who deliberately attempts to interfere with the service is summarily halted. He is not allowed to jeopardize the safety or convenience of the community's interest in his own behalf. Moreover he is obliged to use the drainage system in accordance with prescribed regulations rather than to offend his neighbors by allowing putrescible and offensive waste to accumulate on his premises.

Even in the matters of detail, water-carriage sewage represents the combined effort of many intellects and it is regarded today as nearly ideal as humanly possible to make it, and until something better is evolved it has become a settled custom throughout the world upon which to base sanitary urban development.

Disposal by Dilution.—The question naturally arises what to do with the raw sewage after collection. The first thought is to discharge it into a water course or other body of water. This thought is purely subjective. The suggestion arises simply because of association with the water-carriage method of sewage. It is not the fruit of intelligent reflection. It is only an instinctive impulse which will not stand up under intelligent analysis.

The rights of a community are comparable with those of the individual. No community has the right to discharge raw sewage into a water course to the annoyance and injury of an individual or community located below it who have occasion to use the water of the stream or are annoyed by the odors of stranded putrefying matter. No city or industrial institution has the right to discharge raw sewage into a body of water agitated only by wind and tidal currents in a manner which will endanger the comfort or health or offend the aesthetic taste of those seeking recreational pursuits in or upon its waters. We know that such things are done, but we also know that an enlightened public opinion does not uphold the practice and will sustain any legislation honestly conceived and passed to protect the public safety and abate nuisances.

The argument is often made that every city obliged to obtain its water supply from a polluted source should protect itself against infection by purifying and sterilizing the water before use. The argument has weight when applying to pollution arising in Nature, but is made simply in defense of an evil when the pollution is man-made. Toleration of an offense of this kind is sometimes cheaper, and often politically safer than its abatement, at least for a time, or until an aroused public acts through its legal representative.

Objections to Dilution Method.—Outlets in deep water of raw sewage do not necessarily insure the requisite amount of dilution for natural purification, for the relatively warm sewage rises, seeking temperature equilibrium and at times floats on the surface to be widely dispersed by wind and wave. With similar outlets in the ocean the sewage invariably reaches the water surface by reason of its lower specific gravity. The lighter solids suspended in sewage and all the flotsam receive a wide distribution by wind and wave, and the life of pathogenic germs may be long enough, even in such an environment, to reach shoal water and infect sea food products, rendering sterilization compulsory. Without some such measure an infected locality of this kind may become a reservoir of infection for a large territory.

We can cast a hopeful look forward when we recall that our largest inland city, which for many years has attempted to dispose of raw sewage by dilution with water from Lake Michigan, is now engaged in constructing sewage disposal works of enormous proportions. New York is also planning purification works for a part of its sewage.

The organizations established for the purpose of arousing public interest favorable to legislation prohibiting the indiscriminate dumping of waste and filth into the water courses, for the preservation of a wholesome environment of the coast and lake beaches, for the restoration of conditions of lake and stream suitable for the higher order of fish life and for the preserva-

tion of wild life in general, are doing a good work. Health officials are also doing their part in educating the public and by rules and regulations, judiciously administered, are gradually getting effective action on the part of communities and are converting tourists through recreational districts like the forest preserves to a better regard for a higher standard of sanitation.

These organized efforts are sure to arouse the intelligent thought of the country to the realization that the disposal of raw sewage by the dilution method is not an ideal method of disposal and therefore should not and cannot prevail as a settled custom. It is the fruit of instinct and not of an enlightened intelligence.

Ordinary sewage contains scarcely more than one-tenth of one per cent of putrescible matter, of which about two-thirds is in solution and one-third is in suspension. That in solution is readily oxidized under favorable conditions, while that in suspension is difficult to oxidize, but can readily be reduced to an inoffensive condition by digestion. The existence of putrescible matter in these two states and the difference in the manner of reducing them to stable and inoffensive compounds is a fundamental consideration in the art of sewage purification. This distinction, although of utmost importance, is often ignored in the design of sewage purification works.

Sewage Farming.—For instance, where sewage farming is attempted without the separation of the putrescible matter in suspension from the dissolved portion, more or less objection has arisen because of offensive odors arising from the fermentation of stranded organic solids. This alone is sufficient to prejudice the majority of people against this method of sewage disposal and through prejudice to injure the marketability of the products of the farm. In fact the fertilizing value of the suspended matter in sewage is too small to offset the nuisance and injury arising from fermentation. Besides the insoluble matter is not in shape to be absorbed by plants. The situation is quite different with the putrescible matter in solution, for in this condition it is readily oxidized in percolation through the surface soil by bacterial activities into inorganic compounds in solution suitable for absorption by plant life—the water serving not only for transport but also as the agency through which the food supply can be assimilated. Therefore sewage irrigation is really restricted to dealing with the liquid portion of the sewage. In order to do this economically and inoffensively the separation of the matter in solution from that in suspension is highly desirable to say the least.

Condition of Sewage When Applied to Filters or Beds.—Another instance demanding consideration is the condition in which sewage is applied to the trickling filter or oxidizing bed. Here partially settled sewage, usually the effluent of Imhoff tanks, containing from 30 to 50 per cent of finely divided suspended matter, is sprinkled over a concrete lined bed of underdrained broken stone to facilitate the rapid oxidation by bacterial activity. No fermentation or putrefactive action is expected or provided for in these filter beds. Accordingly the large percentage of putrescible solids arrested in the filter must continue to accumulate, practically unaltered, until an overloaded filter is forced to disgorge or to clog. The disgorged solids, still putrescible, must be caught in a final settling basin and delivered into a digestion tank or dried on underdrained drying beds. The practice of putting into an oxidizing filter putrescible solids which cannot be materially changed in the process which oxidizes the putrescible matter in solution does not appear to be a logical proceeding. Why not prepare the sewage for the filter by first removing the solids and consigning them directly to the process suitable for their proper reduction? We know the trickling filter can remove putrescible matter in solution quickly and successfully and should do so with filters of less volume than is necessary when partially settled sewage is applied to them. Odors certainly will be reduced, there will be less damage of clogging and there is a strong probability that oxidation can be consummated without the aid of a final settling basin.

Advance Preparation of Sewage.—Is it not a fact that sewage purification has not advanced as rapidly as it should? It certainly looks so. It looks as though some fundamental considerations have been overlooked or neglected. There is much evidence to indicate that failure to do what is expected or desired is due, largely at least, to the neglect of properly preparing sewage for purification. This advance preparation should consist in a separation of the putrescible liquid from the putrescible solids with the following rule in mind, namely, that the putrescible matter in solution should go to the oxidizer and the solids to the digester.

The oxidizer may be a trickling filter, intermittent filtration bed, land in irrigation, aeration, dilution with large volume of water, or some other method. The digester may be a lagoon, an open tank or a closed tank with gas collector, whichever meets the local conditions most economically and successfully, but with the distinction that it be for "separate digestion."

Difficulty is conceded in the separation of putrescible matter in solution from that in suspension. Even so, if the rule as stated is fundamentally correct, a way should be found to overcome the difficulties at reasonable cost. It can be done within the practical limits of 90 per cent removal of suspended solids. And to achieve even better results economically is well worth the effort. As in the preparation of water for filters, so in the preparation of sewage for purification, the aid of a coagulant or of aeration or some other similar means to render the fine colloidal suspended matter settleable will undoubtedly be necessary. It follows then that there is need of a more extended use of well designed and well operated settling basins than has been customary heretofore. This additional cost will be offset, in a great measure at least, in a reduced size and cost of structures for purifying the liquid portion of sewage and possibly of the digesters which can then be operated more advantageously and scientifically under the "separate digestion" plan than is possible in the use of the two-stage tanks usually employed in the past.

Considerations of Fundamental Importance.—Even a cursory discussion of the question of sewage disposal cannot be attempted in this or any other brief paper. There are too many ramifications of the subject, each one of which constitutes a subject admitting of considerable elaboration. But every process or art, like the one discussed, possesses certain fundamental principles which must be thoroughly studied before they can be applied intelligently. And more than this it is essential to know the degree to which the application of fundamental principles can be modified to conform with the conditions and requirements in different localities. The author's attempt is to suggest a few considerations which he believes to be of fundamental importance which are now briefly recapitulated:

The disposal of raw sewage by dilution is a practice which appeals to instinct and not to an enlightened intelligence. It should be discouraged.

The purification of sewage in any manner demands advance preparation of the sewage, no matter what may be the process employed.

Since putrescible matter in solution can be most quickly reduced by oxidation and that in suspension by digestion the two should be separated as far as economically possible before attempting purification. In the settling basin 90 per cent or more of suspended matter can be removed. The effluent liquid of the settling basin should be purified by oxidation in a manner best suited to each locality. The settled solids when not dried and made into a fertilizer should go to a digester operated on the "separate digestion" plan with the by-products of digestion utilized wherever and whenever it is found feasible to do so. If oxidation by dilution is chosen the water should be of such volume as to insure sufficient residual oxygen for the support of the higher orders of aquatic life naturally peculiar to the locality.

Sterlization of the basin effluent is always in order where a special provision is needed to destroy infectious germs.

Causes of The Bruckner and The Fritz Weather Cycles

By HALBERT P. GILLETTE

EVERY treatise on meteorology mentions the Bruckner weather cycle, which is commonly assigned a period of 35 years.

Edward Bruckner published in 1891 (Klimataschwangkungen seit 1700) a remarkable monograph in which weather data for 120 years were given in great detail. In the Monthly Weather Review, October, 1928, many of Bruckner's data are given in a translation of an article written by Prof. H. Fritz in 1893. Prof. Fritz does not discuss weather, but he shows that it frequently is correlated with sunspots in a remarkable manner. When scientists express skepticism as to such correlations they should be referred to this article by Prof. Fritz as a starter.

The French meteorologist, Prof. E. B. Garriott, in a "Discussion of Long-Range Weather Forecasts" (Bulletin No. 35, U. S. Weather Bureau, 1904), said: "Bruckner's empirical cycle of 35 years, whatever its cause, undoubtedly exists in the Indian area. Under the title of the Grand Cycle it has long been known in Ceylon."

That the same weather cycle was known at least as far back as Shakespeare's time is evident from the following quotation from Sir Francis Bacon, given in "Climatic Changes" by Huntington and Visher: "There is a toy, which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part) that every five and thirty years the same kind and suit of years and weathers comes about again; as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like, and they call it the prime. It is a thing I do the rather mention, because, computing backwards, I have found some concurrence."

There have been many attempts to find the cause of the Bruckner cycle, but hitherto without success. In "Engineering and Contracting," October, 1928, I outlined an electromagnetic theory of the cause of sunspots; and gave spot cycles caused by each of the eight known planets and several as yet unseen trans-Neptunian planets. Sunspots are, I believe, electromagnetic whirls caused by the magnetic fields of planets and certain comets. I believe that sunspots, in turn, cause the electromagnetic whirls in the earth's atmosphere that we call cyclonic storms.

It was shown in that article that Mars causes sunspots that reach a maximum every 19.5 months. To be more exact it is every 19.509 months. Mars revolves about the sun in 22.584 months.

$$19.509 \times 22 = 429.2 \text{ mo.}$$
$$22.584 \times 19 = 429.1 \text{ mo.}$$
$$\text{But } 429.1 \div 12 = 35.76 \text{ yr.}$$

This 35.76 yr. is the Bruckner cycle, I believe. At any rate it agrees closely with it, both as to length and as to time of occurrence.

I assume that the magnetic axis of Mars is not coincident with its axis of rotation, and rotates slowly backward, which accounts for the sunspot period being shorter than the orbital period. The axis of Mars is inclined nearly 24 deg. to the plane of its orbit, and when the magnetic axis is pointed most directly toward the sun the effect of its magnetic field upon the sun is greatest. This occurs every 429.1 months, as above indicated, or at the time when the axis of rotation is most inclined toward the sun and coincidentally the magnetic axis is pointing most nearly toward the sun. Since barometric gradients on the earth are greatest about when the sun's north pole is most inclined toward the earth, it may be assumed that it is the north pole of Mars that produces sunspot maxima at intervals of 19.51 months and of 429.1 months, the latter being the Bruckner cycle.

The Bruckner cycle is usually not a very pronounced weather cycle; and it requires a smoothed curve over a long period to make it clearly evident. From Bruckner's data the following peak years may be assigned to this cycle:

Bruckner Peaks		Mars Peaks
Cold	Wet	(35.76 yr.)
1738	1745	1738
1773	1775	1774
1813	1815	1809
1848	1848	1845
1878	1878	1881

The Bruckner peaks are in fairly close agreement with the peaks of the Mars cycle of 35.76 yr.; but it should be remembered that a much stronger weather cycle is the one caused by Jupiter, whose peaks are 11.2 yr. apart. A Jupiter peak was due in 1850, but for some reason it was modified by some other planetary body so that it came in 1848, which was one of the Bruckner peak years. And another Jupiter peak was in 1816.

According to C. F. Marvin (Monthly Weather Review, Feb., 1927) the rainfall at San Diego, Calif., showed a fairly well marked periodic curve with peaks in 1881 and 1917, the amplitude being about 15 per cent. This, it will be noted, agrees exactly with the long cycle of nearly 36 yr. that I have assigned to Mars, both as to peak dates and as to length of cycle.

Applying the same method of calculation used above in the case of Mars, I have deduced the following long sunspot cycles assignable to each of five planets:

	Yr.
Mercury	10.13
Venus	20.95
Earth	43.00
Mars	35.76
Jupiter	201.66

Four of these five cycles had been previously discovered, but their causes remained unknown. The 10-yr. and the 21-yr. spot cycles had been discovered by Sir Arthur Schuster. The 36-yr. cycle had been discovered by Bruckner. The 202-yr. cycle had been discovered by Fritz, who had regarded it as a spot and weather cycle of about 200 yr. It had been rediscovered by Clayton ("Earth and Sun," by Huntington, p. 231). Clayton used harmonic analysis of the sunspot numbers, and found a semicycle of about 100 yr., indicating a full cycle of about 200 yr.

There have been five outstanding errors made by most investigators of sunspots and weather cycles: First, they have often failed to distinguish the cycles due to one cause from those due to another cause. Second, they have thought cycles could vary greatly in length. Cycles can be easily confused with one another; and often a peak due to one planet is obscured or even obliterated by another planet; but the cycle assignable to each planet remains constant. Third, they have looked for similar weather conditions in nearby localities, not realizing that storm belts migrate in latitude. Fourth, they have by no means realized that there are a great many sunspot cycles. Fifth, most investigators have assumed that the cycles are multiples of one another in length; usually multiples of the great 11.2-yr. cycle. This springs from a false hypothesis, namely that there are internal forces in the sun that cause waves that are spaced at harmonic intervals.

Not only does each of the eight planets cause a spot cycle somewhat less than its orbital period, as I have shown in the article above cited; but there is clear evidence of many long cycles caused by unseen planets beyond Neptune. Moreover I have found so many short spot cycles that occur at or near the perihelion dates of comets, as to leave no doubt that some comets are sufficiently powerful to cause sunspots. This conclusion is startling only be-

cause astronomers have thought that if planetary bodies cause sunspots it must be through tidal effects produced by gravitation. They have ignored the evidence of powerful electromagnetic effects, as when the heads of certain comets contract enormously at perihelion.

The skepticism that still exists among many scientists as to definite relationships between sunspots and weather springs from the complexity of the forces involved, and from ignorance as to the nature of the forces. The skein is a tangled one, but it can surely be unraveled. For the purposes of the hydraulic engineer, as well as for many other practical applications, it is exceedingly desirable that this skein be unraveled as quickly as possible.

Third Annual Meeting Rocky Mountain Section American Water Works Association

The Rocky Mountain Section of the American Water Works Association held its third annual meeting in Denver, Feb. 14 and 15, 1929. A registration of 28 members and 55 guests, considerably more than that at any previous meeting, indicates the growth of interest in the section and its activities.

The address of welcome was delivered by C. C. Schrepferman, president of the Board of Water Commisioners of Denver. The technical papers presented were as follows:

"Distribution Systems and Service Pipes," by P. R. Revis, City Engineer, Cheyenne, Wyo.

"A Small Filtration Plant," by Chester Truman, Superintendent, Northfield Water Co., Colorado Springs, Col.

"La Junta's Sewage Pumping Plant," by Geo. E. Hine, City Engineer, La Junta, Col.

"Taking the Hardness Out of Water," by R. E. McDonnell, Consulting Engineer, Kansas City, Mo.

"Engineering Problems in Connection with Water Rights," by Geo. M. Bull, Consulting Engineer, Board of Water Commissioners, Denver, Col.

"Legal Problems in Connection with Water Rights," by Malcolm Lindsay, Attorney, Board of Water Commissioners, Denver, Col.

"Wells as a Source of Municipal Water Supply," by Wynkoop Kiersted, Jr., Consulting Engineer, Kansas City, Mo.

Round table discussions were held on mechanical vs. slow sand filters, prechlorination, and miscellaneous water works subjects.

Talks illustrated with lantern slides and motion pictures included:

"The St. Francis Dam Failure," by R. E. McDonnell.

"Water Purification and Sewage Treatment Equipment," by E. M. Kelly, representing The Dorr Co.

"Pipe Line Construction at Colorado Springs," by J. J. Wilson, representing the National Tube Co.

"Trenching Machines," by T. R. Elkins, representing the Wilson Machinery Co.

Demonstrations of coagulation, filtration and zeolite softening were given by E. W. Lasley, Vice-President, The Flox Co., and Dana E. Kepner, Colorado State Sanitary Engineer, both of Denver, Col.

Inspection trips included the shops and equipment yard of the Denver municipal water works, where demonstrations of tapping and other pipe work were given; and the plant of the Gardner-Denver Co., where the manufacture and operation of compressed air tools were shown.

Vaudeville entertainment, following the annual banquet, was made possible by a small registration fee paid by non-members.

The election of officers resulted as follows:

Chairman—P. R. Revis, Cheyenne, Wyo.

Vice-Chairman—D. D. Gross, Denver, Col.

Secretary-Treasurer—Dana E. Kepner, Denver, Col.

Directors (elected)—E. C. Gwillim, Sheridan, Wyo.; Wm. E. Neilson, Santa Fe, N. Mex.

Directors (held over)—D. V. Bell, Rock Springs, Wyo.; Paul S. Fox, Santa Fe, N. Mex.; E. A. Lawver, Ft. Collins, Col.; A. W. Stedman, Canon City, Col.

Exhibits of water works equipment were omitted, at the request of the Manufacturers' Association.

Relative Death Rates in Villages With and Without Public Water Supplies

There are ample data on the reduction in the general death rate, and especially in death rate due to water-borne disease in municipalities, which reductions are caused by the purification of a water supply of a municipality which previously had been supplied with water from a polluted source. Data regarding relative death rates in villages provided with public water supplies and those without public water supplies have been very meager. Some interesting information on this subject is given in Ohio Health News of Feb. 1, which contains the following tables for Ohio villages. The villages in each class are between 1,000 and 2,000 in population and the villages are located at widely separated parts of the state.

The 14 villages, without a public water supply during the period 1915 to 1927 inclusive, which were selected are as follows: Antwerp*, Cardington, Cedarville, Cleves, Doylestown, Georgetown*, Jamestown, Manchester*, Mechanicsburg, Richwood, St. Clairsville, Spencerville, Stryker and Yellow Springs*.

The 11 villages with a public water supply during this period, which were selected, are as follows: Addyston, Archbold, Baltic, Centerburg, Hubbard, Magnolia, Malvern, Mt. Blanchard, New Concord, Pleasant City and Shawnee. All these villages are provided with ground water supplies of satisfactory quality. The tables follow:

Death Rates in Villages Without Public Water Supply

Year	Total Population	Total Deaths All Causes	Total Deaths Typhoid	Average Population	Death Rate per 100,000 All Causes	Death Rate per 100,000 Typhoid
1915	18,473	288	6	1,320	1,557	32.5
1916	18,520	314	3	1,322	1.695	16.2
1917	18,594	298	3	1,327	1,602	16.1
1918	18,641	333	5	1,331	1,784	26.8
1919	18,688	308	2	1,334	1.650	10.7
1920	18,735	294	7	1,388	1,570	37.4
1921	18,783	270	6	1,342	1,438	31.9
1922	18,831	294	1	1,345	1.560	5.3
1923	18,879	345	1	1,349	1,825	5.3
1924	18,927	308	2	1,353	1,626	10.6
1925	18,975	302	2	1,356	1.590	10.5
1926	19,023	337	1	1,360	1,770	5.2
1927	19,071	293	1	1,364	1,535	5.2
Averages—13 years				1,342	1,620	16.4

Death Rates in Villages With Public Water Supply

Year	Total Population	Total Deaths All Causes	Total Deaths Typhoid	Average Population	Death Rate per 100,000 All Causes	Death Rate per 100,000 Typhoid
1915	11.640	134	1	1,058	1,152	8.6
1916	11,868	163	1	1,079	1,378	8.5
1917	12,098	154	2	1,100	1,273	16.5
1918	12,324	244	3	1,120	1,980	23.4
1919	12,652	141	0	1,141	1,113	0.0
1920	12,788	164	1	1,162	1,285	7.8
1921	13,016	136	2	1,183	1,044	15.4
1922	13,243	152	2	1,204	1,149	15.0
1923	13.472	131	0	1,225	973	0.0
1924	13,700	136	1	1,246	993	7.3
1925	13,928	146	2	1,267	1,047	14.3
1926	14,156	148	1	1,287	1,047	7.1
1927	14,384	146	0	1,308	1.016	0.0
Averages—13 years				1,183	1,189	9.5

It will be noted that the average population of the villages listed without a public water supply is more than those listed with a public water supply. It is to be expected that the typhoid death rate would be greater in the former than in the latter, 16.4 against 9.5 per 100,000, or 73 per cent greater, but the total death rate is also considerably greater, being 1,620 against 1,189 per 100,000, or 36 per cent greater.

While the conclusions to be reached from such a small number of municipalities are not necessarily final, they confirm the general conviction of public health authorities that a public water supply is a factor in improving the health of a community in other ways than merely reducing the death rate due to water-borne diseases.

*These villages have since 1927 either installed or have a public water supply under construction.

Zoning.—More than 640 cities, towns and villages in the United States now have zoning ordinances. These communities comprise close to 60 per cent of the urban population of the country.

Cost Accounting System Minneapolis Garbage Collection Department

Data on Garbage Collection Work in 1928

By GUSTAVE A. MOE
Cost Accountant, City Comptroller's Office, Minneapolis, Minn.

THE collection and incineration of garbage for the city of Minneapolis is done under supervision of the City Engineer. The house collection division consists of a fleet of 40 1½-ton trucks used as a single unit, each carrying one tank. A loading station is maintained to which these tanks are delivered. Unloaded from trucks these tanks are delivered by tractor truck and trailer in lots of six to the incinerator. The incinerator is located in the north end of the city. The loading station is in the south end of the city. Some garbage is hauled direct to the incinerator.

The area of the city is 58.7 square miles; average haul—8 miles; the maximum haul—14 miles; service rendered—weekly. The city requires all garbage to be wrapped and placed in cans at alley end of lot. Property owners furnish their own garbage cans. All collections are made between hours of 8 A. M. and 4 P. M. Drivers and collectors receive monthly salaries of $135 per month. They are allowed two weeks' vacation and two weeks' sick leave in each calendar year.

No ashes nor rubbish are collected by the city. No collection of garbage is made from downtown business places. This garbage is collected by hog feeders. They collect from hotels, cafes and large boarding houses, but are not allowed to collect from private homes.

Ledger Accounts.—The department prepares a budget for each year's operations. This budget estimate is prepared in October of each year for the next year's operation, and shows the amount of funds necessary under a code classification, which constitutes the general ledger accounts of the department.

A Cost Ledger is maintained which carries the cost control accounts of Office and Superintendence, Collectors' Salaries (helpers only), Truck and Trailer Operation and Maintenance, Garage Expense, Plant Expense, Vacations, Sick Leave and Compensation, Hauling, Loading Station to Crematory and Loading Station Expense. This Cost Ledger shows at all times the total costs of each account.

Subsidiary Ledger Accounts are maintained for each piece of equipment and each of the other accounts as shown on the cost ledger. Each account on the subsidiary ledger supports the detail information, control accounts then must reconcile to the accounts maintained on the General Ledger of the Accounting Division.

STARTED WORK A. M. | |
FINISHED WORK P. M. | |

City of Minneapolis Power and Crematory Committee
DEPARTMENT OF SANITATION COLLECTION DIV.

12M 2-28 50753

Daily Report on Collection of Garbage

Load Number	Tank Number	STREETS COLLECTED FROM	Gaso. Gals.	OIL Cyl.	OIL Tran.	Grease Lbs.	Net Load Weight Lbs.

Date _____ Truck No. _____

Driver _____ Odometer Finish _____

HELPERS _____ " Start _____

_____ Miles Per Day _____

REMARKS _____

Form Used for Daily Report on Garbage Collection

Salary Accounts.—Office and Superintendence Account is charged with the Salaries of the Superintendent, Route Foreman, Bookkeeper, Cost Accountant, Clerk and Claim Clerk, Auto Maintenance Allowance of Superintendent and Route Foreman, Office Supplies and Office Expense.

Collectors' Salaries Account is charged with the salaries of the helpers; there are two helpers with each collection truck.

Operation Account.—Truck and Trailer Operation and Maintenance Account controls subsidiary ledger accounts for each truck and trailer (trailers were used with a trail-a-Ford unit, but a new purchase of single unit trucks has now been made). Each truck is charged with operating expense, such as insurance, gasoline, oil, grease, alcohol, operator's salary; maintenance expense includes all repair labor, repair parts and proportion of repair shop expense. Depreciation is figured on a four year life after salvage value has been deducted. Storage and Equipment overhead is based on a per cent rate of tons collected. Tire Account is maintained for each tire, showing in detail miles of service, which is then charged to the truck as an operating expense. Trailer expense was kept in the same manner as trucks.

Miscellaneous Accounts.—Garage Expense Account is charged with all undistributed Garage Expense and is prorated to collection trucks as stated in previous account.

Plant Expense is charged with the

Summary of Truck and Collection Costs for 1928

	Collection Cost (45 Trucks)	Hauling, Station to Crematory (8 Trucks and Trailers)	Grand Total Cost of Collection
Operation	$ 52,928	$ 5,117	$58,045
Tires	1,440	----------	1,440
Trailer Cost	3,567	1,662	5,229
Insurance	298	53	351
Maintenance	8,269	2,303	10,572
Repair Shop Expense	4,779	332	5,111
Depreciation	11,174	2,132	13,306
Total Truck Cost	$ 82,456	$11,599	$94,055
Total Collection Mileage	268,514	26,593	295,107
Average Cost Per Mile	$0.307	$0.436	$0.319
Helpers' Time	$91,110	----------	$91,110
General Expense	$24,284	$1,689	$25,973
Total Cost	$197,850	$13,287	$211,138
Average Cost Per Mile	$0.737	$0.50	$0.715
Tanks Collected	34,557	16,724	51,281
Average Cost Per Tank	$5.725	$0.795	$4.117

FORM S6 2M 5-28 5217

TRUCK MAKE_____

TRUCK NO._____

GARBAGE COLLECTION DEPARTMENT

DAILY TRUCK OPERATION

MONTH BEGINING_____19___ AND ENDING_____19___

Date	Operating Expense						Maintenance Cost			TOTAL OPERATING MAINTENANCE COST	Total Tanks	Total Miles	COST PER MILE	HELPERS - TIME	GENERAL EXPENSE	TOTAL DAILY COST
	Operators Time	GASOLINE Gal.	GASOLINE Cost	OILS Qts.	OILS Cost	GREASE Lbs.	GREASE Cost	REPAIR LABOR	REPAIR PARTS	REPAIR SHOP						

Form Used for Daily Report on Daily Truck Operation

Plant Expense, being Light, Heat, Repairs to Buildings and Watchman.

Vacations, Sick Leave and Compensation Account is charged with all vacation, sick leave and workmen's injury compensation and is shown as cost per ton of garbage collected.

Hauling from Loading Station Account is charged with expense of truck tractors from subsidiary ledgers, account of each kept in same manners as trucks.

Loading Station Account is charged with salaries of loading station men, supplies and insurance.

From the above accounts the reader will understand that a complete record of costs is being maintained. From these records reports for the executive, for the superintendent, the route foremen and the Council Committee are made, giving to them a measuring stick with which to measure the efficiency of this department. The worth of this system was recently demonstrated when bids for 25 new trunks were submitted; the new trucks were purchased upon the basis of facts brought out by the cost records of past performance of the trucks used by this department, which the engineer greatly appreciated when making his recommendations.

Cost Increases with Cold Weather.—The cost increases quite noticeable after September are due to several causes. The same route must be covered during entire year. In the cold months that follow September much garbage is burned at home, but not all, so collection must be made for partly filled cans. Tonnage drops, cost per ton goes up, also most difficult, icy conditions for collectors, while in warmer months more green vegetables, wet garbage—all have tendency to increase tonnage. Service is the same and the personnel is almost constant, although perhaps there is a small lay-off in the cold weather.

Cost Analysis for the Year of 1928

Office and Superintendence:		
Salaries	$	7,442.20
Auto Maintenance		540.00
Office Expense		1,275.99
Total Office Expense	$	9,258.19
Cost Per Ton (Office)		.31
Cost of Collection:		
Helpers' Time	$	91,110.23
Cost Per Ton (Helpers)		3.03
Truck Operation and Maintenance		65,010.09
Truck Depreciation and Insurance		11,472.05
Trailer Operation and Maintenance		1,367.98
Trailer Depreciation		2,049.72
Total Operation and Maintenance	$	79,899.84
Cost Per Ton (Operation and Maintenance)		2.66
Garage Expense:		
Labor	$	4,052.32
Supplies		881.04
Garage Equipment Depreciation		98.55
Total Garage Expense	$	5,031.91
Cost Per Ton (Garage)		.17
Plant Expense:		
Labor	$	2,280.48
Supplies		1,310.12
Insurance		131.00
Total Plant Expense	$	3,721.60
Cost Per Ton (Plant)		.12
Vacations, Sick Leave and Compensation		7,377.52
Cost Per Ton		.25
Total Cost of Collection	$	196,399.30
Total Tons Collected		30,042
Cost Per Ton (Collection)	$	6.54
Cost of Hauling—Stations to Crematory:		
Tractor Operation and Maintenance	$	7,452.24
Trailer Operation and Maintenance		436.75
Tractor Depreciation and Insurance		2,185.76
Trailer Depreciation		1,225.66
Total Tractor and Trailer Cost	$	11,300.41
Cost Per Ton (Hauling)		.89
Cost of Stations—Labor and Expense	$	3,438.32
Cost Per Ton (Stations)		.27
Total Cost—Stations and Hauling	$	14,738.73
Total Tons Hauled by Tractors		12,729
Cost Per Ton	$	1.16
Total Cost Delivered to Crematory	$	211,138.03
Total Cost Per Ton		7.03

Remembering also that 110,000 cans get service yearly at an approximate cost to the taxpayer of $2 per year or 4 ct. per collection per week.

Operating costs of trucks during winter months increase at least 25 per cent on account of increased consumption of gasoline and oil. Overhead expense also increases on account of fuel used to heat garage and buildings. Skid chains used in the winter months cost approximately $700, which also increases the cost.

Government Statistics of the Cement Industry for January

The ratio of the operations to the capacity of the American portland cement industry during the month of January was 46.5 per cent, according to figures released Feb. 15 by the Bureau of Mines of the U. S. Department of Commerce. During the month 9,781,000 bbl. were produced; 5,735,000 bbl. were shipped, and there were in stocks on hand at the end of the month 26,696,000 bbl. Production in January, 1929, was 0.1 per cent more, and shipments 12.3 per cent less than in January, 1928. Stocks at the mills were 6.3 per cent higher than a year ago.

FORM S7 250 5-28 5218

YEAR PURCHASED_____

MAKE_____

INSURANCE PREMIUM_____

DEPRECIATION RATE_____% YEARLY DEPRECIATION_____ YEARS TO RUN_____

GARBAGE COLLECTION DEPARTMENT

TRUCK OPERATION YEAR OF 19___

COST_____

SCRAP VALUE_____

TRUCK NO._____

MONTH	OPERATING COST	TIRES	INSURANCE	MAINT COST	REPAIR SHOP EXPENSE	ACCUMULATED DEPR.	TOTAL TRUCK COST	MILES TRAVELED	COST PER MILE	HELPERS TIME	GENERAL EXPENSE	TOTAL COST	TOTAL COST PER MILE	TANKS COLLECTED	TOTAL COST PER TANK

Form Used for Report on Trucks

Application of Highway Research Results to City Pavement Design and Construction

Effect of Character of Subgrade on Pavement Operations

By C. A. HOGENTOGLER
Senior Engineer, U. S. Bureau of Public Roads

The problems of both city and highway engineers differ in some respects, but on the other hand they are similar in many respects. The highway engineers' findings, therefore, may assist the city engineer in his work and the city engineers' experience may prove helpful in like manner to the highway engineer. We accordingly are printing herewith an abstract of a report presented Jan. 15 before the City Engineers' Division of the American Road Builders' Association at the annual convention of the association. The report was submitted by Mr. Hogentogler, Chairman of the Committee on Subgrades and Pavement Bases.

THE following definitions facilitate the discussion:

Breakage: Subdivision of concrete pavements or bases by cracks due to load. This includes transverse cracks spaced closely (3 to 5 ft. apart), longitudinal cracks in half-width (about 9 or 10 ft. wide) road slabs, corner and subsequent progressive cracking.

Cracking: Subdivision of concrete pavements or bases by cracks due to lack of uniform subgrade support, with or without load, to contraction caused by temperature or moisture change in the concrete or to shrinkage in the concrete. This includes transverse cracks spaced generally not closer than about 10 ft. apart and single longitudinal cracks in full width (about 16 to 20 ft. wide) road slabs, and also cracks which, during the setting of the concrete, may occur and subdivide pavements or bases into comparatively small fragments.

Dry Subgrades: Cohesionless sands or gravels resting above the ground water level. Any type of material resting very high about the ground water level (15 or 20 ft.) covered with a perfectly impervious pavement and being located where adjacent sidewalks and buildings prevent the possibility of surface water entering the subgrade soil.

Wet Subgrades: Until more is known about the efficiency of drainage for intercepting and removing water from the subgrade and for lowering the ground water level, it is a wise precaution to consider all graded materials, silts and clays which have access to water entering through cracks or joints in the pavement, grass plots or parks on the sides, and water bearing strata or capillarity from beneath as wet subgrades.

Influence of Subgrade Support.—The influence exerted by subgrade support upon pavement performance has long been recognized. Investigators of this problem until recently, however, have furnished only results limited in application to practical road construction. Realizing this situation the U. S. Bureau of Public Roads has attacked the problem and assisted by the U. S. Bureau of Soils and Chemistry, the Massachusetts Institute of Technology, the Ohio State University, the University of South Carolina, and the State Highway Departments of Maryland, Virginia, Ohio, New Hampshire, Missouri and Minnesota has made encouraging progress. A report now being prepared discloses this progress by

1. Pavement behavior as related to pavement design and construction, climate and subgrade support.
2. Subgrade support as related to both the raw constituents of soils and the attendant field conditions.
3. An arrangement of subgrade according to performance into a small number of practical groups.
4. The identification of the soils of each group by means of laboratory tests.
5. Theory which explains the stability of subgrades under service conditions.
6. The functions and practical application of drainage, subgrade treatments, porous subbases, compacted base courses, beam strength and thickness, crack control and steel reinforcement in rigid pavements as related to subgrade support.

Thus it suggests that preparation of the subgrade, selection of type of pavement and its design are not entirely arbitrary matters but depend instead upon the attendant subgrade soil conditions. And, consequently it explains how research findings can be utilized with profit in pavement practice.

Increased Subgrade Support Versus Stronger Pavements.—Stage construction employing admixtures of granular materials, bituminous materials, etc., furnishes the most promising possibility for increasing subgrade support. But the mere incorporation of granular material for instance is only one part of the stabilization process. Continuously vibrating and manipulating the soil when wet, dry, frozen and thawed, by traffic furnishes the other and the very necessary part of the operation. This requires time and consequently is generally impractical in city work.

The high stability of relatively thin old traffic bound roads or macadams therefore should not lead one to expect equal stability in newly constructed stone courses similar either in material or thickness, nor that the high support furnished by natural sand and gravel subgrades will be duplicated by moderately thick sand and gravel layers laid on clays. Thus when stage construction is not practical, designing the pavement to suit the subgrade support is more practical than attempting to improve the subgrade to suit a particular pavement design. This does not discredit, however, the use of precautionary measures for preventing loss of subgrade support.

Rolling the Subgrade.—The character and condition of the subgrade soil determines the extent of rolling required. A small amount of rolling to smooth off sands after they have been thoroughly sprinkled, seems to be sufficient. Compacting silts and fine grained clays with a very heavy roller breaks down their natural structure and thus, to the depth affected by rolling, increases their support.

Micaceous and distomaceous silts, coarse grained gumbo and fine grained clays containing organic matter, rebound upon removal of load. Consequently these subgrades are not permanently compacted by rolling. The micaceous friable soils may be compacted slightly when wet but are apt to expand upon drying. Due to their low density these subgrades furnish low support when either wet or dry. The adobes in contrast, are hard and compact when dry and may be temporarily compacted when damp. They expand very appreciably however when subjected to water, such as may be furnished for instance by capillarity or even that furnished by newly laid concrete.

Thus, in order to prevent detrimental volume change, an attempt should be made to obtain uniform density in elastic subgrades and to prevent their ab-

sorbing moisture during the setting of the concrete.

Porous Base Courses.—According to the Highway Research Board, base courses of cohesionless gravel, field stone, etc., laid on clays, not only fail to benefit rigid pavements in all cases but have been known to increase the extent of heave due to frost and the extent of breakage. This can easily be explained. Base courses containing large voids permit the evaporation and thus promote the flow of capillary moisture in the subgrade. Also they provide space in which free water entering from the road surface or from the subgrade and that furnished by the condensation of capillary moisture, may accumulate. Thus in the absence of drainage outlets, or when ice or lack of proper maintenance prevents drainage outlets from functioning, pourous base courses serve as reservoirs under the road surface. Under these conditions more water to produce frost heave is furnished by the presence than by the absence of porous base courses. Furthermore the large voids permit the penetration of the soft clay from beneath during thaws and may cause the base course to settle unequally, thus furnishing non-uniform support productive of pavement failure.

Substitution of cohesionless sand and gravel layers for high shrinkage adobe not subject to frost action, reduced the amount of cracking in a thin (4½ in. thick) concrete pavement in California. Also, according to Professor F. H. Roe, a sand base course reduced the length of longitudinal cracking in Ohio. Otherwise the presence of sand layers, according to available evidence, neither increases nor decreases the extent of cracking in superimposed concrete pavements of standard thickness.

To lead out water furnished by springs through separate drains, and to intercept that furnished by water bearing strata with trenches and tile drains placed under the edges of the pavement, seems preferable to using porous base courses promiscuously for drainage purposes. Except where rock subgrades furnish water through a number of crevices and where the thickness of base course can be made equally approximately to the depth of frost penetration, base courses containing large voids may not prove beneficial.

Compacted Base Courses.—Layers of well graded sand-clay, gravels with binder and compacted slag and crushed stone as under courses for rigid pavements may prove beneficial and as foundation for non-frigid pavements are of course a necessity.

Compacted slag bases, according to Professor Roe, were very much more efficient than porous base courses for reducing pavement cracking in Ohio. They also reduced cracking when used under concrete bases in Cleveland.

Tight compacted base courses, layers of sand-clay for instance, prevent the entrance of water into the subgrade from above and also the escape of capillary moisture by evaporation. They should therefore be more effective than porous base courses for preventing detrimental volume changes in subgrades having high shrinkage properties. Separating the sand-clay layer from the subgrade by a coating of light bituminous material will probably furnish additional protection against volume change in the subgrade.

When the subgrade support is low, but uniform, increasing the strength of concrete pavements or bases seems preferable to the use of subbases for obtaining insurance against load cracking.

Compacted base courses, however, in two way may serve to reduce the detrimental effects of concrete base cracking due to causes other than load. They eliminate to the depth of their thickness inequalities in subgrade support and therefore when properly drained may actually reduce in concrete bases the number of cracks. Or in contrast, by offering high frictional resistance to slab sliding, compacted bases may possibly increase the number but decrease the width of cracks in concrete bases and thus cause but little visible cracking to occur in the wearing course.

When contemplating the use of compacted base courses as foundations for non-rigid pavements two questions arise: First, can they be constructed properly, and second, is the thickness necessary to furnish adequate load distribution permitted economically?

Macadams for instance to be properly rolled and compacted require a firm subgrade reaction and this is not furnished by the elastic subgrades. The abrupt deflections with rebounds caused by traffic and possibly non-uniform volume change in these soils, are apt to seriously disturb subsequently such semblance of bond as might be obtained in these pavements initially.

Stage construction is apt to gradually work this elasticity out of the top layer of these subgrades and a very thick layer of well graded coarse materials with binder may facilitate the construction of macadams. Otherwise attempts to construct macadams on highly micaceous or coarse clay subgrades are apt to result in failure. The use of bituminous instead of mineral binders, in this case, furnishes a problem for future investigation.

Silts which are apt to become wet and fine grained clays which cannot be properly drained also are undesirable as subgrades for macadams. Initial compaction can be secured in the base course when these soils are fairly dry, but the thickness of base course required to furnish adequate load distribution on these very low supporting soils when wet is apt to be prohibitive. This is additive to the danger of ruptured bond due to excessive frost heave in the silts.

Newly constructed macadams may serve as satisfactory bases however on stiff clays and on silts when drainage lowers the ground water level in sufficient amount. Here precautions should be taken to eliminate the occurrence of soft spots in the subgrade and the penetration of the soft subgrade soil into the interstices of the macadam base course.

Three possibilities for guarding against this type of trouble are: Crowned subgrade with drains under the side edges of the pavement to intercept ground water and remove water which is apt to collect on the surface of the subgrade; separation of macadam from subgrade by means of a fine grained insulating layer to prevent soft soil from working upwards, and oiling of clay subgrades to prevent softening due to moisture absorption from above. The silts soften primarily due to capillarity from below and therefore may not be much benefited by the oil coat. Oiling and insulating layers may prevent also unequal settlement in porous base courses.

According to published report, fabric reinforcement has proven beneficial for preventing failure in compacted base courses laid on low supporting soils in England. The fabric reinforcement in this case is placed between the compacted slag base and the tar macadam top. The committee is attempting to secure additional information on the results furnished by this practice.

Quality of Concrete Bases.—Both the thicknesses of base and the quality of concrete required depend upon the subgrade conditions. Bases supported by soft wet subgrades must of necessity be thicker than those supported by firm, dry subgrades. Lean mix bases, however, on wet subgrades, even when made thicker than those on dry subgrades, may not prove serviceable because lean mix concrete is apt to disintegrate when subjected more or less continuously, especially in the presence of frost action, to excessive moisture.

The U. S. Bureau of Public Roads Impact Tests apply illustrate how subgrade condition influences the resistance of slabs, covered or not with bituminous tops to load breaking. This series of tests was performed on but one type of subgrade soil and under arbitrary conditions of load. Furthermore, the slab resistance was measured by impact instead of by static loads. Therefore the slabs thicknesses referred to below are illustrative, but unless substantiated by additional observations, they should not be applied to pavement design.

According to these tests a lean mix slab on a well drained subgrade requires a thickness of but 6½ in. to be equiresistant with a rich mix slab 6 in. thick. On the wet subgrade in contrast, a lean mix slab requires a thickness of 7½ in. to be equiresistant with a rich mix slab 6 in. thick. Furthermore, a rich mix slab on a wet subgrade requires a thickness of about 7½ in. to be equiresistant with a similar slab 6 in. thick laid on a dry subgrade and a lean

mix slab on a wet subgrade requires a thickness of about 8½ in. to be equiresistant with a similar slab 6 in. thick laid on a dry subgrade.

Also in the Bates Road Tests, the lean mix bases were less resistant than the rich mix bases to breakage. The subgrade in this case, it will be recalled, carries a high capillary moisture content (about 30 per cent by weight) which resists reduction by artificial drainage. Thus it conforms to the saturated subgrade in the Arlington tests.

According to Bulletins 1 to 7, inclusive, issued by the State of Illinois during the progress of the tests, the asphalt and brick pavement area requiring replacement was from 50 to 100 per cent greater in the lean mix than in the rich mix base sections.

The replacement area required, for instance, in the asphalt sections 14, 15, 17 and 20 (rich mix bases) was but two-thirds of that required in comparable sections 12-A, 13, 16 and 19 (lean mix sections). And the replacement area required in the brick top sections 27, 28 and 30 (rich mix bases) was but one-half of that required in the comparable sections 29-A, 29-B and 32-A (lean mix sections).

Disintegration of the concrete was observed in the lean mix bases laid on wet subgrades in Arlington, in the lean mix base laid on wet locations in the Chevy Chase Experimental Road and, according to A. P. Howell, Municipal Engineer, in old concrete bases generally in the Borough of Leyton, England.

Increasing the thickness of lean bases will not eliminate this objectionable feature. Therefore, the advisability of using them on wet subgrades is questionable. The rich mix bases to be equiresistant to breakage should be made thicker when laid on wet than on dry subgrades, or, as will be shown later, they should be reinforced with fabric when laid on the wet subgrades.

Steel Reinforcement.—This precautionary measure has been found effective for reducing the number of cracks in concrete pavements and the extent of breakage due to load. And when used in concrete bases, reinforcement has been found effective for preventing loss of sand cushion productive of failure in brick pavements, the occurrence of wide cracks in asphalt tops, and the faulting of base fragments which causes pavements laid on highly expensive soils to develop rough riding surfaces.

According to the Highway Research Board, "steel reinforcement reduces more economically than increased concrete thickness cracking in concrete pavements." Generally the Highway Research Board Report stated that mesh reinforcement 25 to 56 lb. per 100 sq. ft. and bar mat reinforcement 64 lb. per 100 sq. ft. reduced cracks more than one additional inch of concrete."

The average length of slab for instance in a large mileage of concrete roads, five years or more old, varied from 18 to 25 ft. In similar roads reinforced the average slab length was about 40 ft. According to P. M. Tebbs, the average length of comparable pavement slabs two years old in Pennsylvania were as follows: Plain concrete, 33 ft.; with 25-lb. mesh, 45 ft.; 65-lb. mesh, 67 ft. According to E. R. Hoffman, reinforced pavement slabs laid at bridge approaches, on new fills, on soft subgrades and on side hill fills in the State of Washington, suffered less cracking than similar slabs laid on more favorable subgrades but not reinforced.

In the DeKalb experimental road, 12 ft. wide and constructed by Dean A. N. Johnson in 1912, the average length of slab, after 13 years of service, were as follows: Plain concrete, 16 ft. long; 42-lb. mesh reinforced slabs, 50 ft. long.

These facts furnished by roads in service should not be discounted simply because they are not explained by available mathematical computations.

Also, according to the Highway Research Board, the initial load cracking, which is the beginning of breakage, is prevented more economically by thickness of concrete than by steel reinforcement. The extent of subsequent breakage, however, is very appreciably reduced by the incorporation of steel reinforcement. After test, the plain concrete Bates Road section (No. 54) 5 in. thick required replacement equaling 45 per cent of its original area. The comparable section (No. 55), of the same thickness but reinforced with steel fabric, in contrast required but 0.3 of 1 per cent of its original area to be replaced.

According to R. M. Morton, for instance (reporting on roads in Santa Barbara County, California), "Wire mesh and steel bar reinforcement did not always prevent cracks caused by subgrade settlement, but materially prevented the number of breaks and prevented cracks from opening and raveling.

When the subgrade settled from 1 to 4 in. under reinforced sections, cracks appeared around the edge of the depression. They did not ravel, however, nor cause unevenness of surface. When similar settlement occurred under plain concrete slabs, marked differences in surface elevation resulted with cracks open from ⅛ to ¾ in.

And, in addition to this, the mesh reinforced slabs laid on wet subgrades in the Arlington tests, resisted impacts very much larger (about 50 per cent) than similar slabs not reinforced.

Furthermore, according to information received by the committee, many British municipalities have found fabric reinforcement effective for preventing failure in concrete bases laid on low supporting soils.

Thus reinforcement may actually prevent cracks from forming, it may confine cracks to microscopic dimensions and within limits it prevents separation and faulting of pavement fragments, thus eliminating the excessive roughness which causes high impacts productive of further breakage.

Function of Wearing Courses.—Wearing courses do not necessarily increase the resistance of the bases to initial cracking caused by load. They protect, however, concrete bases against progressive breakage following initial load cracking and macadams against surface disintegration productive of total failure. Also, the good appearance of wearing courses is not appreciably changed by either frequent patching or replacement of small areas. Thus depending upon conditions, wearing courses may increase very appreciably the service value of pavements.

Data furnished by impact tests of the U. S. Bureau of Public Roads show that for slabs 4, 6 and 8 in. thick, consisting of either lean or rich mix or laid on drained or saturated subgrades, the addition of bituminous wearing courses failed to increase the resistance of concrete bases to load cracking. The Bates Road Tests substantiate this by disclosing generally that the presence of a wearing course exerted little or no influence on the resistance offered by concrete pavement slabs to corner cracking caused by wheel loads.

The Bates Road Bulletins referred to previously, however, disclose also the efficiency of wearing courses for reducing the extent of necessary pavement replacement. The replacement area required for instance in sections 14, 17 and 20 with bituminous tops is but one-eighth of that required in comparable sections 61-B, 54 and 52 without wearing courses. That required in sections 12-A, 14 and 17 with 3-in. thick bituminous tops is but one-fourth of that required in comparable sections 13, 15 and 18 with 2-in. thick bituminous tops.

The performance of city pavements generally bears witness to the protection afforded concrete bases by flexible wearing courses. Close observations clearly disclose that in many instances the bases are broken and furthermore that their fragments are displaced vertically. The roughness of the riding surface of such bases if not covered would probably be increased by attempts to maintain the many cracks, and by the further displacement and spalling of slab fragments due to contact with wheels of vehicles.

Impacts caused by this increased roughness combined with softening of the subgrade (depending on its character) due to entrance of water through the many cracks could be expected to rapidly increase the extent of breakage. A substantial wearing course prevents to some extent the individual movement of slabs, the entrance of water from above and thus very appreciably retards the progress of breakage in the base.

The protection afforded by brick wearing courses to concrete bases was

very clearly shown by the report on the Chevy Chase experimental road.

In the Bradley Lane experiments merely the addition of a wear and water resistant bituminous macadam wearing course changed a very unsatisfactory traffic bound road into a serviceable heavy duty highway.

The benefits furnished by wearing courses for preserving the integrity of bases are demonstrated more readily by reduced maintenance costs than by theories of mechanics. Nevertheless the protective action of wearing courses does not compensate for inadequate base strength. For also, according to the Bates Road Tests, one additional inch of concrete is more effective for reducing the extent of breakage due to load, than one additional inch of bituminous top.

Attempts to weaken the bars therefore when wearing courses are used may change into complete pavement failure the benefits which may be derived otherwise by covering adequate bases with substantial wearing courses.

Practical Application of Research Results.—Only experience can disclose the type and thickness of pavement required to give efficient service under the variety of conditions encountered in the various cities. The objectionable features developed by individual pavements subjected to particular service conditions, must be analyzed with respect to causative factors. Only then can the proper preventive measures be determined. Thus inspections of existing pavements to determine the current type of objectionable features and the application of research results to determine the proper preventive measures, furnishes the only rational basis for the design of pavements to be constructed in the future.

Conclusion.—Thus, according to research, every pavement operation from the rolling of the subgrade to the treating of the finished road surface depends upon the character of the subgrade. And furthermore the outstanding characteristics of subgrades can be identified in the laboratory. This does not, however, minimize neecssity for making examinations of subgrades in the field.

The corrective suggestions are of two kinds: Those which may be termed strong indications and those which may be regarded as established facts.

The strong indications require further substantiation before they can be accepted as recommendations for standard pavement practice.

The established facts, in contrast have been duly substantiated by the performance of roads in service and therefore should be applied in standard pavement practice.

Among the strong indications are:

1. Oiling clay and silt subgrades may greatly reduce the possibility of their working up into flexible base courses constructed subsequently. Meagreness of results furnished by this procedure prevents drawing conclusions. Practice deserves trial.

2. Insulating layers of fine grained granular materials prevents soft clays and silts from working up into interstices of overlying base courses. Substantiated more for materials with binder than for cohesionless materials.

3. Porous base courses serve to reduce extent of detrimental front heave under rigid pavement. Evidence contradictory. When used they should be both drained and separated from clays and silts by layers of fine granular materials.

4. Compacted base courses may reduce the amount of cracking in pavements due to non-uniform support and when offering high frictional resistance to slab sliding may reduce the width but increase the number of cracks due to construction and shrinkage in the concrete. Requires verification.

5. Drainage is effective for reducing the extent of cracking in rigid pavements and failure in flexible pavements. Evidence contradictory. True or not depending upon many conditions, only some of which are now known.

6. Light mesh reinforcement increases very appreciably the resistance of slabs laid on wet subgrades to initial load cracking. Evidence consistent but too meagre to furnish definite conclusions. This, if true, can be considered as an additional benefit furnished by reinforcement which should be used for other purposes in pavements laid on these subgrades.

Among the established facts are:

1. Increasing the thickness of concrete pavements increases their resistance against breaking into small pieces due to load.

2. Rich mix concrete furnishes more resistance to load breaking than less mixed bases.

3. The lean mix bases are apt to suffer appreciable disintegration when subjected to moisture and for this reason may not be suitable for wet subgrades.

4. Steel reinforcement is more economic than increased concrete thickness for reducing the number of length of cracks due to lack of uniformity in the subgrade or to shrinkage or contraction in the concrete.

5. Steel reinforcement tends to hold fragments of cracked slabs together and thus reduces the extent of spalling and faulting, in pavements. Also it serves to prevent progressive breaking down of pavements under load.

6. Wearing courses are essential to prevent disintegration beginning with surface abrasion in untreated traffic bound roads and macadams.

7. Wearing courses serve to protect cracked concrete bases against breakage due to traffic.

8. The full benefits to be furnished by the use of either steel reinforcement or substantial wearing courses can be obtained only when concrete pavements or bases have adequate resistance against initial load cracking.

Public Improvements Not Extravagance

The natural resources, creative ingenuity and productive energies which have made possible our tremendous city expenditures for streets, sewers, schools, bridges, water supply, civic centers, libraries, museums, parks, boulevards, transportation systems, elimination of grade crossings, street widenings, traffic control, slum clearance, harbor clearance, harbor developments and air ports, and the great pressure of the needs which have called forth these improvements have placed before our cities an unexampled temptation to extravagance. Nevertheless, the cities cannot be charged with lavish waste. With very few exceptions, the things built were needed long before they were completed. It is easy to make sweeping charges of extravagance; it is not so easy to name the street that should not have been paved, the bridge that should not have been erected, the school that is superfluous. If we are to judge by useless structures, city authorities have shown far more sagacity than have business men. For every folly of public construction I can show you a score of private follies. The true extravagance in public works has come not from engaging in unnecessary projects, but from unnecessarily high standards, from faulty planning, from relying upon inexperienced advice, from bad business methods, and from dealing with corrupt contractors and officials. For example, in Duluth, a few years ago, approximately $1,000,000 of unnecessary expenditure was eliminated from the plans of the new city hall as the result of a study of space requirements and the inauguration of an architectural competition, both of which were initiated by the local civic research organization and the Taxpayers' League of St. Louis County. Similarly in St. Paul, the Bureau of Municipal Research through better planning and design brought about an even larger reduction in the school building program. In both cases the improvements were needed. The danger of extravagance appeared not in the project itself, but in the unnecessary luxurious method of going about the work. This is an enhanced danger for cities as for individuals during a period of unexampled financial prosperity.—Extract from the annual report of Luther Gulick, Chairman Governmental Research Association, presented Oct. 15 at the 17th annual meeting of the association.

Five-Bladed Turbine Runner.—Adoption of a five-bladed hydraulic turbine runner, the first ever built, has made it possible to effect an estimated saving of 25 per cent in the total cost of the falls of the Ohio plant at Louisville, Ky.

How a Small Village Improved Its Water Supply

Spring Source Has Several Interesting Features

By FRANK C. ROE

Shields, Jordan & Roe, Hydraulic, Sanitary and Electrical Engineers, Chicago, Ill.

THE village of Niagara, Wis., was confronted in 1926 with the question of improving and increasing its water supply. A limited amount of money ($20,000) was available which created an interesting problem for the consulting engineers, who were called in late in the year to survey the situation and make a report.

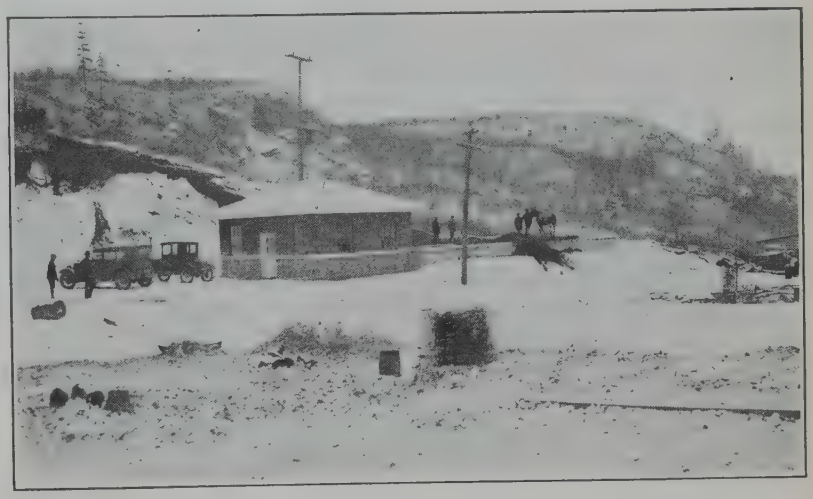
General Conditions.—Niagara is situated in Marinette County on the Menominee River. The terrain is unusually rocky and uneven except for some sandy bottom land, there being nearly 200 ft. difference in elevation between the high and low points within the village limits. The village is built adjacent to the large Kimberly Clark Co.'s paper mill, which is the only industry. The company owns a great majority of the property, pays most of the taxes, and hence was vitally interested in the problem. The mill of course is also the largest water consumer, even though the village water is not used for any part of the paper making process. The population was given as 1,943 in the year 1927.

The Former Water Supply.—The existing water supply in 1926 was from a shallow well drilled into the gravel and rock, within 50 ft. of the Menominee River and about 100 ft. from a similar well supplying water to the paper mill. The water became more unsatisfactory and unusable from year to year, presumably on account of fissures in the gravel and rock which permitted the river water to enter the wells. While there was no indication of B. coli present at any time, strong tastes of wastes from the paper mill were noticeable. The color corresponded closely to the river water which was yellow (40), had a turbidity of 30 P. P. M., total dissolved solids—87.1 P. P. M., and suspended matter—30 P. P. M. The hardness was 80 P. P. M. and the alkalinity 60 P. P. M.

Fissures also evidently opened between the two wells since the village supply became worse when the mill pump was shut down. In other words, the pasage from the village well through the mill well and to the river was more free than the passage directly between the river and the village well. It became necessary to pump continually for 24 hr. to maintain the supply, although this was found to be due to leaks which were located after the construction of the new works, and which will be discussed later. However, the apparent lack of quantity added to local dissatisfaction with the existing supply. The pump in use was barely able to lift water to the bottom of the equalizing reservoir, and then only during the night; so the average pressure was lower than desirable.

New Supplies Considered.—Four separate sources and schemes for a new supply were considered, namely: filtered Menominee River water, impounded and filtered surface water, deeper wells located at an appreciable distance from the river, and infiltration galleries in spring areas. The costs of the first three mentioned were prohibitive and the quality questionable in the first scheme. The practicability of utilizing the spring water source hinged only on quantity since the cost would be very low in comparison with the cost of utilizing other sources, and the quality was excellent. Accordingly weirs were installed to measure the quantity from two separate spring areas, namely: the Burden Springs and the Harding Springs. The flow out of the Burden Springs varied between 60,000 and 130,000 gal. per day. The Harding Spring was more variable since it was located on higher ground. Two other springs were considered and rejected, one because of inaccessibility and the other because of insufficient supply.

Since the village consumption of water as shown by the service meters (excluding that used by the paper mill) was only 21,000 gal. per day, the plan of building infiltration galleries was adopted and the Burden Spring selected for the supply. The other springs of course are still available in case the demand increases beyond the present supply, which condition is unlikely. Other reasons for selecting the Burden Spring were, that it was closer to a pump house and reservoir site, closer to the existing distribution system, and actually had the best quality of water. The iron content was 0.1 P. P. M. magganese 0.0 and the bacterial count was 40 per c.c. at 37° C. with no trace of B. coli.



Pump House and Reservoir

Plans were prepared in the spring of 1927 and construction completed in October, 1927. The essential parts of the project are the infiltration gallery, receiving chamber, 160,000-gal. storage reservoir, pump house, pumping equipment, and connecting pipe lines.

The Infiltration Gallery.—The infiltration gallery consists of a main 572 ft. in length of 12, 10 and 8-in. diameter pipe, laid through the center of the spring area, with seven 8-in. diameter branches, to particularly good springs, which bring the total length to 804 ft. The pipe is standard vitrified bell and spigot tile pipe laid with open joints. The ditch was hand dredged from 3 to 6 ft. deep and each length of pipe laid with the aid of an improvised wooden box, or the flowing sand (the gallery being below the water table) would have inundated the

pipe before it could be set correctly and the gravel placed. Immediately after setting a length of pipe, coarse gravel (¾ to 1½ in.) was placed all around it at least 6 in. in thickness followed by a course of clean sand or very fine gravel of the same or greater thickness, before the box was removed and the sand from the sides allowed to flow.

The lower end of the main collecting tile enters the receiving chamber where the velocity of the water is retarded sufficiently to enable any sand to be retained; the clear water continues through by gravity to the storage reservoir. A drain line is also connected to the receiving chamber which permits the total flow to by-pass the reservoir thus facilitating cleaning. The chief reason however for this separate receiving chamber was that the topography made a pressure pipe or "inverted siphon" of some 200 ft. length necessary between the lower end of the gallery or collecting pipe and the storage reservoir. Since the pressure pipe rises into a weir box in the pump house adjacent to the reservoir, it was essential that no sand suspended in the water enter it at the higher end thereby promoting a possibility of clogging at its lower elevation.

Interior of Pump House

The Reservoir and Pump House.—The weir box in the pump house is constructed of concrete and covered with glass. Flow is thence by gravity to the adjacent reservoir. The flow line over the 16-in rectangular brass measuring weir is approximately the same elevation as the high water line in the reservoir so an overflow weir was located opposite the measuring weir, the crest of which is 3 in. higher than the measuring weir. Thus when the reservoir is filled the flow automatically enters the overflow which is connected to the aforementioned drain. The reservoir is of reinforced concrete 34 ft. wide, 56 ft. long and 14 ft. deep.

The pump house is constructed of reinforced concrete, stone and pressed brick. It contains in addition to the weir box: a vacuum pump, two 4-in. by 3-in. Allis-Chalmers horizontal centrifugal pumps directly connected to 25-H. P., 3,500-R. P.M. motors, pressure control equipment, pipe gallery (below), and a Brown electric flow meter (indicating, integrating, and recording) of the orifice plate type.

The pump suction is connected to the reservoir and the discharge is directly into the distribution system, the connection being only 200 ft. distant. The former equalizing reservoir of 50,000-gal. capacity continues to serve as such. It is located some 145 ft. above the pumps. The level is maintained in the equalizing reservoir with a differential of 4 ft., by means of a Golden-Anderson altitude valve. When both pumps are placed in series for fire pressure the altitude valves serve another purpose by automatically closing before the reservoir reaches the high water level.

When operation started in October, 1927, the demand for water appeared to be almost as great as the supply and was over 100,000 gal. per day, or nearly 80,000 gal. more than the service meters indicated. A survey showed a leak of about 60,000 gal. per day in a 3-in. service line to the paper mill and the remainder was accounted for by wide open inlets to sewer flush tanks. The recorded flow at the pump house now checks closely with the meter readings, although the domestic consumption has increased considerably beyond the previous 21,000 gal. per day average, due to the great difference in quality of water.

The flow of water from the springs appears to have increased during the past year, although this fact may result because there has been no protracted dry weather period. At no time were readings lower than 100,000 gal. per day recorded, while the maximum rate was approximately 140,000 gal. per day. There has been no change in quality.

Although definite data are not available, the cost of operation, including the services of an operator, is lower than that of the former supply, being about $1,500 per year. The total average cost of pumping per million gallons 1 ft. high is estimated at $0.95, including the operator's salary.

All of the pipe work, including the infiltration gallery, was installed by a village crew under the direction of the superintendent of streets.

The reservoir, pump house and receiving chamber were constructed by the C. R. Meyer & Sons Co., General Contractors, Oshkosh, Wis. The works were designed and the construction supervised by Shields, Jordan & Roe, Hydraulic, Sanitary and Electrical Engineers, of Chicago, Ill.

27,000 Fatalities Auto Toll for 1928

Twenty-seven thousand people were killed in automotive accidents during the year 1928. A daily average of 87 fatalities during the month of December brought the year's total up 5 per cent higher than the record for 1927. The jump during December is the highest of any month during the year just closed. Twenty-seven hundred fatalities represents the month's toll.

There may be a grain of consolation in the fact that the 5 per cent increase between 1927 and 1928 is just half the percentage increase between 1927 and the preceding year, and the lowest increase in any year since 1920.

Washington, D. C., stands out in bold relief among the larger cities with no fatalities for December.

Half of the pedestrians killed during December were 55 years of age or over.

Ninety-two cities and eight states, representing a population of 46,000,000, reported to the National Safety Council which compiled the statistics.

The death rate in the cities over 500,000 population is shown below. The figures in the fifth column, headed "Death Rate," are annual rates per 100,000 population. The populations used in computing these rates are furnished by the U. S. Census Bureau.

(Over 500,000 population)

City	December 1928	December 1927	12 Months 1928	12 Months 1927	Death Rate
Baltimore, Md.	17	9	136	139	16.4
Boston, Mass.	11	11	118	115	14.8
Buffalo, N. Y.	19	9	123	122	22.1
Chicago, Ill.	108	78	909	824	28.8
Cleveland, Ohio	26	24	232	218	23.0
Detroit, Mich.	40	38	330	397	23.9
Essex Co., N. J.	16	....	158	.....	a
Los Angeles, Cal.	34	46	313	340	a
Milwaukee, Wis.	14	7	113	.....	20.8
New York City	92	83	1,030	1,050	17.1
Philadelphia, Pa.	30	30	292	291	14.1
Pittsburgh, Pa.	10	23	....	164	.....
St. Louis, Mo.	32	23	216	147	25.5
San Francisco, Cal.	16	24	.....	158	.....
Washington, D.C.	0	4	78	70	14.1

a. Rate not computed because of no population estimate by the United States Census Bureau.

Municipal Tax Rate in Massachusetts.—The average tax rate of all municipalities in Massachusetts is $28.42 per $1,000 of assessed valuation.

Size and Behavior of Sand in Rapid Sand Filter Plants

Methods of Examining and Comparing Sands

By PAUL HANSEN
Of Pearse, Greeley & Hansen, Consulting Engineers, Chicago, Ill.

THE bed of filtering sand has received less study and has undergone less change than any other element in rapid sand filter plants since this type of filtration received general recognition in the late nineties as an effective means for the purification of public water supplies.

The Fuller Experiments.—The report of George W. Fuller on his classic experiments at Louisville, Ky., in 1897, makes but brief mention of factors controlling the design of the sand bed. He commented on the difficulty of determining the most favorable thickness of sand bed and size of sand grains because of the obscuring effect of various other items, more particularly coagulation and sedimentation. He thought the 24 in. of crushed quartz in the Warren filters too thin and concluded that less expensive clean natural sands were equally effective. He also considered the 4 or 5 ft. of sand in the Western filters too thick. The 30 in. of sand in the Jewel filters seemed to be reasonably satisfactory. Little was adduced with reference to size of sand grain. The crushed quartz in the Warren filters had an effective size of about 0.51 mm. and the natural sand in the other filters had an effective size of about 0.43 mm.

Without further inquiry of importance a thickness of sand of 30 in. has been generally accepted as about right from the time of the Louisville experiments to the present day. The size of sand grain has likewise remained essentially the same. As a result of observation at the operation of the Little Falls, N. Y., filter plant, built in 1902 for the East Jersey Water Co., there was a tendency to reduce the effective size of the sand grain to 0.35 mm. and this remained the standard size until recently, and is even now often specified.

Ohio Studies of Purification Plants.—Observations of the Ohio State Department of Health beginning with the special study of water purification plants in 1908 indicated that with sand grains having an effective size of more than 0.35 mm. the purification was not always satisfactory. However, the conclusiveness of these observations has been disputed. With the acceptance of sterilization with bleach or chlorine there has been a tendency toward larger sand grains up to about 0.50 mm. This functions better with the high rate of wash water first adopted at Cincinnati in 1907, gives longer filter runs and is less troublesome when microscopic organisms are numerous.

Changes in Filter Design.—Every other feature of rapid sand filter installations has changed so greatly that a filter plant of the early type common in the 1890's would hardly be recognizable as embodying the same general processes as a plant built in the last decade. Concrete has replaced wood, rectangular instead of circular filter units are nearly universal, compact and convenient arrangements have been worked out, much larger filter units are in common use, filter valves are hydraulically or electrically controlled, mixing chambers have become an important feature, elaborate and improved methods of chemical feed have been developed and better housing has been provided. Many of the latest and largest plants are embellished with architectural effects of a high order, whereas in the olden days a plain brick building or a galvanized iron shed was regarded as good enough.

Method of Specifying Sand.—The first pronounced movement for a closer examination of filter sand began in about 1916 and took the form of a rebellion against prevailing methods of examining filter sand. Up to that time, the method devised by Allen Hazen in 1892 for sand examination and recording had been accepted without much question and engineers were in the habit of specifying sand by designating a certain "effective size" and "uniformity coefficient," terms devised by Hazen as a measure of the filtering characteristics of sand. Effective size is that size of sand grain of which 10 per cent by weight is finer than; uniformity coefficient is the ratio of that size of sand grain of which 60 per cent by weight is finer than to that size of grain of which 10 per cent is finer than.

Objectors to this description of sand were opposed to it on two counts, namely, (1) that the stratification that takes place in a rapid sand filter as the result of washing with a rising current of water renders the terms effective size and uniformity coefficient no longer applicable as terms descriptive of filtering characteristics, and (2) that the use of millimeters and the terms effective size and uniformity coefficients were mystifying to the average contractor or dealer in sand and, also, to many engineers.

The Hazen Method.—To do Hazen credit, it should be pointed out that he never recommended specifying sand by naming the desired effective size and uniformity coefficient and it has always been his practice to specify the percentages by weight lying between specified mean diameters as determined by shaking a sample through a set of carefully calibrated sieves. In other words, he placed more importance on the entire plotted curve of sand grain sizes than he did on the two points which determine effective size and uniformity coefficient. But these terms seem to have caught the popular fancy among engineers and as they could be written into specifications with less thought and effort than was required to describe the full analysis, the temptation to use them has been strong.

Standard Sieves.—As an alternative to the Hazen method (as generally used), objectors proposed a specification based on separations by standard sieves but it soon developed that standard sieve cloth was not being made with sufficient uniformity of weave nor did different manufacturers conform to a common diameter of wire. If sufficiently accurate and uniform sieve cloth could be obtained it would unquestionably simplify sand analysis because calibration of sieves, according to the Hazen procedure, is a rather difficult and tedious process and, in fact, was often neglected.

As a demand had developed in a number of industries for standard sieves, the United States Bureau of Standards undertook to establish a standard set of sieves. The openings in the complete set varied in the ratio of the fourth root of two. By omitting every other sieve the openings would vary in the ratio of the square root of two. This latter series is most suitable for sand analysis. This ratio of variation is a convenient one and lends itself readily to plotting. It was also proposed to designate the diameter of sieve openings in microns so that whole numbers could always be used. If millimeters are disturbing to the intellect of contractors and sand dealers, the use of microns might prove disastrous.

To meet the limitations in methods of manufacture, and, also, variations in the products of different manufacturers, certain tolerances in both openings and wire diameters were permitted. In 1926, a committee of the American Society for Testing Materials, in co-opera-

tion with manufacturers, adopted the standards of the Bureau of Standards tentatively.

Care Needed in Use of Sieves.—These standard sieves are fairly satisfactory for the examination of filter sand, but care should be exercised to use sieves that have been examined and checked by the Bureau of Standards, a service which the bureau renders for a very moderate fee. The sieve separations may be approximately converted to mean diameters, as defined by Hazen, by multiplying the sieve opening by the factor.

Results obtained by the use of standard sieves may vary from results obtained by calibrated sieves, according to the Hazen method, by as much as 5 per cent. In view of the greater accuracy of the Hazen method, and the large amount of data that have been and are being obtained by his method, the committee on Sand Testing and Recording of the American Water Works Association has not as yet deemed abandonment of the Hazen method advisable.

Behavior of Sand Beds.—While methods of examining and comparing sands are necessary there are many behaviors of sand beds in connection with which little has been done and little is known. The greatest advance in the study of these behaviors was made by Baylis at Baltimore in studying cracking and mud ball phenomena. He was able to relate these to the accumulation of organic matter and organisms about the sand grains and he elaborated microscopic methods of examining these accumulations, which have given us a much better understanding of their functioning, for both good and evil. Microscopic examination of sand grains has now become a routine practice in a number of large filter plants.

The Am. Soc. C. E. Studies.—In 1928, James W. Armstrong, acting in behalf of a committee of the American Society of Civil Engineers on filter materials for sewage and water works, of which William E. Stanley is chairman, enlisted the co-operation of some fourteen filter plant operators, including Mr. Baylis at the Chicago Filter Testing Station, in carrying on experiments on the behavior of filter sands under a variety of conditions and with different waters. The general object of these experiments is to determine the optimum size of sand grains and the best depth and grading of sand beds to meet the requirements of waters of different types. The experiments are being made in batteries of seven glass tube filters attached to and operating in parallel with a full size filter. One of the seven glass tube filters is provided with the same sand as is contained in the large filter and is maintained as a control. The others are provided with sand beds of different sizes and depths, the sand being prepared uniformly by Mr. Armstrong in Baltimore and shipped to the various experimenters. Certain uniform procedures and observations have been adopted, but they are subject to variations and elaboration as the experiments progress.

After many years it now appears that we are on the way to a careful study of behavior of the sand bed in rapid sand filters. Whether these studies will result in changes in the design of the sand bed, remains to be seen. Whether they do or do not result in changes in design, they have already and will continue to add to our knowledge of behavior and, hence, add to our ability to control the performance of filter plants.

Acknowledgment.—The foregoing paper was presented at the 1929 Convention of the Illinois Society of Engineers.

Research Graduate Assistantships at University of Illinois

To assist the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a Research Graduate Assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of April. The nominations are made by the Executive Staff of the Station, subject to the approval of the President of the University. Nominations are based upon the character, scholastic attainment, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of the undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

Additional information may be obtained by addressing M. S. Ketchum, Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Course in Traffic Engineering

The School of Engineering of the University of Pittsburgh is conducting a course in traffic control engineering. The course began Feb. 15 and will continue for 15 weeks, meeting each Friday evening from 7:50 to 9:30. Enrollment was opened to anyone who is interested in the traffic problem. The fee for the course was $15.

The course covers the following subjects:

Traffic surveys and statistics; city and regional planning and street design; traffic delays; traffic signs, signals and other guides; electric traffic control systems and their design; organization of traffic educational campaigns; planning to prevent traffic accidents; organization and functioning of traffic bureaus; study of enforcement procedure; typical traffic laws and ordinances; terminal facilities; work of police departments; the parking problem, including a study of its economic aspects; segregated and through traffic streets; elevated and express roadways; pedestrian control; mass transportation and its relation to traffic congestion; zoning and decentralization; the taxicab problem; methods of increasing street capacity; regulation of traffic moving on conflicting routes.

Professor Lewis W. McIntyre, who is conducting the course personally, is in charge of the highway and highway transportation work at the university, and is vice-president of the National Highway Traffic Association and consulting engineer to the city of Pittsburgh on the downtown electric traffic control system.

The course is designed especially to interest and instruct those engaged in design, construction and operation of highways, the regulation of traffic and reduction in traffic accidents.

A New Method of Spreading Rock Asphalt

How a Concrete Finishing Machine Was Used

By JOHN L. HUMBARD
President John L. Humbard Construction Co., Knoxville, Tenn.

A STANDARD concrete-finishing machine, with an added raking device, is being used in constructing a 9-mile pavement of Kyrock on a concrete base, in Cheatham County, Tennessee. Similar machines have been used to spread natural rock asphalt laid cold. The rock asphalt is being laid on a 7-5-7 in. (parabolic curve) concrete base, with a 1¼x6-in. curb on each edge. The base, too, is finished smooth and a paint coat is applied ahead of the asphalt.

The rock asphalt is dumped in piles on the base ahead of the finishing machine, as shown in Fig. 1. Men with shovels then roughly spread the piles, throwing the material back in front of the rake, as shown by Fig. 2. It then contains many lumps, and the purpose of the rake is to break these down, even up the asphalt layer and provide a fine, homogeneous material ahead of the finishing machine screed. Except for the added raking device, the machine is of standard construction in every respect.

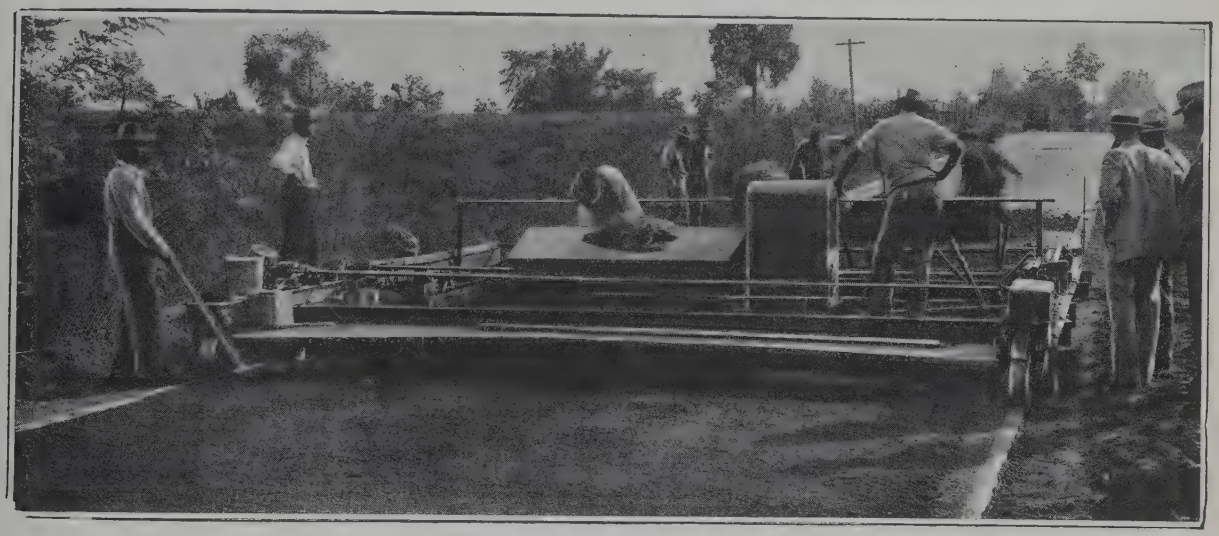


Fig. 1—Rock Asphalt Being Spread with a Concrete Finishing Machine

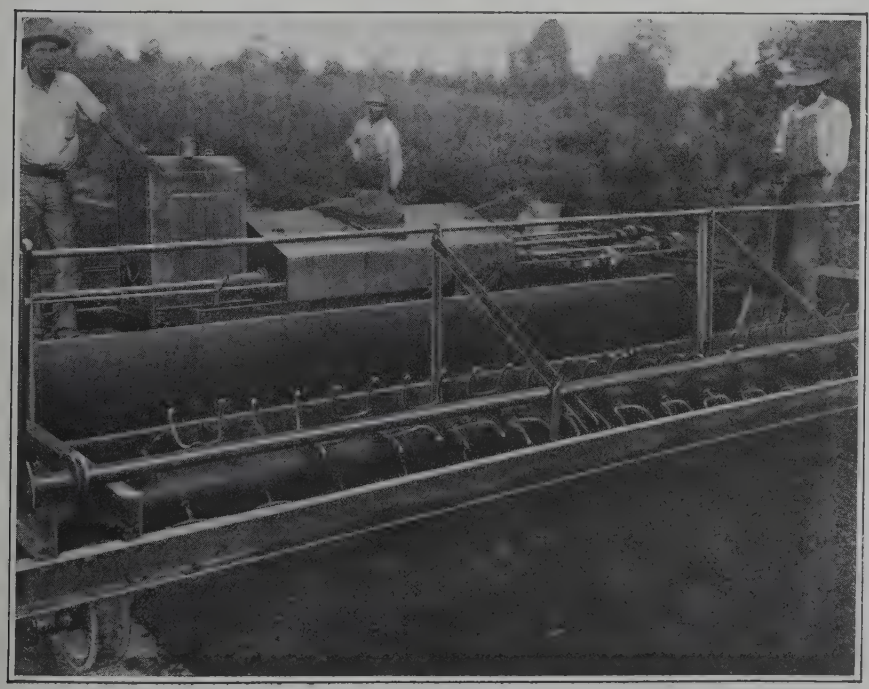


Fig. 2—Close-up View of Rotating Rake Attachment to Finishing Machine

As shown by Fig. 2, a revolving rake is supported by a separate carriage, which is connected loosely to the finishing machine proper. The shaft is driven from the finisher by a sprocket and chain and is rotated at a relatively high speed. The teeth are set in spirals along and around the shaft so as to reach practically every portion of the roadway width. Both the rake carriage and the finishing machine run on the curbs. In finishing, the shoes of the screed are set so that the screed finishes the asphalt ½ in. high to allow compression by the roller. Referring to Fig. 2, the piling up of the asphalt ahead of the screed is to be observed. Its fineness and freedom from lumps compared with the material ahead of the rake is also to be noticed. In Fig. 1 the asphalt as spread by the screed

is shown. This illustration also shows the whole gang of nine men required to spread and finish the asphalt ready for rolling.

This machine finishing is found to have several advantages. It gives a uniform yield in square yards per ton; less than 0.1 sq. yd. per ton variation has been shown. The output compared with raking by hand is about doubled. There is less supervision required by the inspector to make certain that the proper amount of material is being got into the spreads at all times. The labor is cut down; besides the foreman and finishing machine operator, there are only nine men. With this gang an average of 3,000 sq. yd. a day is being surfaced.

This road is on Route No. 1, Memphis to Bristol Highway, and is one of the most important roads in Tennessee. The work is being done by the writer's firm as contractor for the state highway department, whose engineers have expressed appreciation of the exact and satisfactory work of the finishing machine. It is possible that, due to the highly satisfactory results being obtained on this project, the Department of Highways will specify a finishing machine for all jobs of this character in the future.

Financial Statistics of City Governments for 1927

The U. S. Department of Commerce announces a summary of the financial transactions of the 250 cities having a population of over 30,000 for the fiscal year 1927.

The total payments for operation, maintenance, interest, and outlays for permanent improvements for cities having over 30,000 population were 92.5 per cent greater than similar payments of the government of the 48 states, and 0.1 per cent greater than those for the Federal government for the fiscal year 1927.

Preliminary statements for each of the cities have been released for publication as rapidly as the reports were received, the first of these statements appearing Oct. 31, 1927. A summary, by cities, will be available within a few weeks giving financial statistics which will show assessed valuations and tax levies, revenues collected, governmental-cost payments, and indebtedness.

Expenditures.—The payments for operation and maintenance of the general departments of the city governments of the 250 cities for the fiscal period 1927 amounted to $1,750,707,093, or $40.98 per capita. In 1926 the comparative per capita for operation and maintenance of general departments was $39.18, and in 1917, $19.07. Payments for the operation of public service enterprises, as water works, electric light plants, and similar enterprises, amounted to $162,470,940; interest on debt, $319,248,702; and outlays for permanent improvements, including those for public service enterprises, $1,091,959,616. The total payments in 1927, therefore, were $3,324,386,351; in 1926, $3,052,645,496; and in 1917, $1,108,021,565.

The per capita net governmental-cost payments for operation, maintenance, and interest for 146 cities covered by census reports since 1903 were $52.64 in 1927, $50.30 in 1926, $24.58 in 1917, and $16.41 in 1903.

The totals include all payments for the year, whether made from current revenues or from the proceeds of bond issues. Proceeds from the issuance of debt obligations are not considered revenue receipts.

Of the 250 cities covered by this report only two were lacking in revenues sufficient to meet all operating expenses and interest, while 70 realized enough revenues to meet all their payments for expenses, interest, and outlays and to have a balance available for paying debt.

Of the total municipal payments in 1927, 52.7 per cent was for operation and maintenance of general departments; 4.9 per cent, operation and maintenance of public service enterprises; 9.6 per cent, interest on debt; and 32.8 per cent, outlays for permanent improvements.

Of the payments for operation and maintenance of general departments, 38.2 per cent was for education; 20 per cent, protection to person and property; 8.9 per cent, highways; 8.5 per cent, general government; 7.7 per cent, sanitation or promotion of cleanliness; 6.1 per cent, charities, hospitals and corrections; 4.7 per cent, miscellaneous; 3.4 per cent, recreation; and 2.4 per cent, conservation of health.

The percentages for 1927 show but little change from those for 1926, the largest in each of the years being for education and the smallest for conservation of health.

Of the total payments for outlays for permanent improvements, the principal items were $394,963,016, or 36.1 per cent, for highways; $198,560,613, or 18.2 per cent, for education; and $196,317,702, or 17.9 per cent, for public service enterprises.

Revenues.—The total revenue receipts of the 250 cities for 1927 were $2,945,511,729, or $68.96 per capita. This was $713,084,994 more than the total payments of the year, exclusive of the payments for permanent improvements, but $378,874,622 less than the total payments, including those for permanent improvements. The revenue receipts included $1,888,704,574 from general property taxes; $64,457,627 from special taxes; $88,941,226 from licenses; $233,292,693 from special assessments; $144,292,408 from subventions, donations, and pension assessments; $136,454,248 from interest, rents, and highway privileges; $290,941,918 from earnings of public service enterprises; and $98,427,035, the remainder, from poll taxes, fines, forfeits, and escheats, and earnings of general departments.

The per capita net revenue receipts of 146 cities covered by census reports since 1908 were $69.77 in 1927, $66.14 in 1926, $31.97 in 1917, and $21.14 in 1903.

Indebtedness.—The net indebtedness (funded or fixed debt less sinking fund assets) of the 250 cities amounted to $5,479,284.872, or $128.27 per capita, in 1927, this being an increase of 7.0 per cent over that for 1926. The per capita net debt of 146 cities covered by reports since 1903 was $134.27 in 1927, $128.13 in 1926, $80.75 in 1917, and $44.71 in 1903.

While in 1927, as compared with 1926, there was an increase of $361,112,478 in net debt for the 250 cities as a whole, there were 84 individual cities which showed a decrease in their net indebtedness.

A comparison of the aggregate increase in net indebtedness with the total payments for outlays discloses the fact that 33.1 per cent of the permanent improvements for 1927 were financed from proceeds of bond issues.

New Jersey Sewage Works Association Meets in March

The New Jersey Sewage Works Association, the Engineering Bureau of the State Department of Health of New Jersey cooperating, will hold its 14th annual meeting on March 22 and 23, 1929, at the Stacy-Trent Hotel, Trenton, N. J.

The meeting is planned for municipal officials, particularly those connected directly or indirectly with sewers, sewage disposal and allied activities and provides an opportunity for the exchange of information and ideas through the medium of round table discussions. Authorities will present papers on various phases of sanitation, which with the discussions, we believe, will be of practical value to those attending the meeting.

The value of the work which this association has done in the past is attested by the fact that a dozen other states have formed similar associations patterned after the original New Jersey Sewage Works Association. The attendance last year was over 250 from New Jersey and ten other states. John R. Downes, Bound Brook, N. J., is secretary of the New Jersey Sewage Works Association.

Developed Water Power in the United States on Jan. 1, 1929.—The total capacity of water wheels installed in water power plants of 100 hp. or more in the United States on Jan. 1, 1929, was 13,571,530 hp., an increase of 1,275,530 hp., or 10.4 per cent, during 1928. The increase in 1927 was only 575,000 hp. The gain in 1928 was therefore more than twice that during 1927.

Definitions of Terms Used in Sewerage and Sewage Disposal Practice

An Am. Soc. C. E. Manual of Engineering Practice

THE formulation of definitions of terms used in sewerage work was initiated in 1915 by the American Public Health Association. The work was continued by committees of the Association until 1924. In May of that year the Sanitary Engineering Division of the American Society of Civil Engineers appointed a committee on definitions. Joint action between the two societies followed and on Oct. 22, 1924, at a joint meeting of the Sanitary Engineering Division of the American Society of Civil Engineers and the Sanitary Engineering Section of the American Public Health Association, a tentative report based on the work of the two committees was presented. The work was then continued and on Oct. 13, 1927, the joint report of the two committees was adopted by the Sanitary Engineering Division of American Society of Civil Engineers. The American Public Health Association adopted this report on Oct. 20, 1927, and on July 16, 1928, the report was also adopted by the Board of Directors of the American Society of Civil Engineers. The latter society has published recently the list of definitions as one of its manuals of engineering practice.

Definitions of Terms Used in Sewerage and Sewage Disposal Practice

A. B. C. Process (Alum, Blood, Clay).—A method of deodorizing and precipitating sludge by the addition of alum, charcoal, or some other material and clay, to the raw sewage. One of the earliest satisfactory methods of clarification by chemical precipitation.

Activated Sludge.—Sludge settled out of sewage previously agitated in the presence of abundant atmospheric oxygen.

Activated Sludge Method.—See **Activated Sludge Process.**

Activated Sludge Process.—Sewage treatment in which sewage standing in or flowing through a tank is brought into intimate contact with air and with biologically active sludge, previously produced by the same process. The effluent is subsequently clarified by sedimentation.

Aeration.—The process or method of bringing about intimate contact between air and a liquid by allowing finely divided air to pass through the liquid or the finely divided liquid to pass through air.

Air-Lift.—A device for raising sewage or other liquid by injecting air in and near the bottom of an open discharge pipe submerged in a well of the liquid to be raised.

Alignment.—The direction of the axis of a sewer in plan.

Alternating Device.—A device whereby sewage may be automatically delivered into different parallel treatment units in a cycle following a predetermined sequence.

Appurtenances.—See **Sewer Appurtenances.**

Back-Water Gate.—A device for preventing the back flow of sewage or water.

Baffles.—Deflectors of wood, metal, or masonry, placed in flowing liquid to divert, guide, or agitate the flow of such liquid.

Band Screen.—An endless band or belt of wire mesh, bars, plates, or other screening medium, which passes around upper and lower rollers or guides.

Bar Screen.—A screen composed of parallel bars or rods. See, also, **Rack.**

Barn Sewage.—Wash water from stables, considerable quantities of animal wastes.

Basin.—A shallow tank or natural or artificial depression through which liquids pass or in which they are detained for treatment.

Bio-Aeration.—A modification of the activated sludge process in which the sewage and sludge are agitated and aerated by mechanical means, such as paddle-wheels or turbines.

Bio-Chemical Action.—Chemical action resulting from the growth or metabolism of living organisms.

Bio-Chemical Oxygen Demand.—The quantity of oxygen required for bio-chemical oxidation in a given time at a given temperature. the determinations usually being for 5 days at 20° cent.

Biolytic Tank.—A continuous flow tank with hopper bottom, with inlet arranged so as to agitate the sludge by the entry of sewage at the apex of the hopper-shaped bottom. This agitation tank is sometimes followed by a settling tank in which the sludge is detained until removed.

Bleach. — Calcium hypochlorite. (Bleaching Powder.)

Blow-Off.—A waste-gate or device for discharg- accumulated solids or for emptying a depressed sewer.

Branch Sewer.—An arbitrary term for a sewer which receives sewage from a relatively small area.

Branches.—Special forms of vitrified tile and cast-iron pipe for making connections to a sewer. They are called Tee, Y, Tee-Y, Double-Y, and V, from the shapes. (Synonym, Junction Pieces.)

Broad Irrigation.—The disposal of sewage by application to farm land involving the incidental benefit to crops growing out of the irrigation and fertilization resulting from the application of the sewage. (Differs from sewage farming in that the primary purpose is the disposal of sewage while the raising of crops is incidental only.) See, also. **Sewage Farming.**

Cage-Screen.—A screen consisting of a cage, with sides of bars, rods, or mesh, so arranged that it may be lowered into the sewage and raised therefrom for cleaning.

Capillary Water.—Water in the interstices of the soil or of a sand filter, which is not lost by draining.

Catch-Basin.—A chamber or well. designed to prevent the admission of grit and detritus into a sewer.

Catch Pit.—See **Grit Catcher.**

Catchment Area.—The area of a water-shed tributary to a lake, stream or sewer.

Centrifuge.—A device in which sludge is dewatered by rapid rotation and automatically discharged.

Cesspool.—A pit into which household sewage or other liquid waste is discharged and from which the liquid leaches into the surrounding soil, or is otherwise removed.

Chamber.—A general term for a space enclosed by walls or a compartment, often prefixed by a descriptive word as "grit chamber" or "screen chamber" indicating its contents, or "discharge chamber" or "flushing chamber" indicating its office.

Chemical Precipitation.—Sedimentation accelerated by the coagulation of suspended or colloidal matter through the addition of chemicals.

Chlorination.—Treatment with chlorine or bleaching powder for the purpose of disinfection. the retardation of decomposition, or the oxidation of organic matter.

Circumferential Flow.—Flow parallel to the periphery of a circular tank.

Clarification.—The process of removing suspended and colloidal matter from a turbid liquid.

Clarified Sewage.—Loosely used for sewage from which suspended matter has been partly or completely removed.

Coagulation.—The flocculation of colloidal or suspended matter brought about by the addition of some chemical to the liquid, by contact, or by other means.

Coarse-Grained Filter.—General term for contact bed or trickling filter.

Coarse Rack.—A relative term. but generally used when the clear space between bars is 2 in. or more.

Coarse Screen.—A relative term, but generally used when openings are greater than 1 in. in least dimension, except in the case of racks. See, also, **Coarse Rack.**

Coefficient of Imperviousness.—The ratio, expressed decimally, of effectively impervious surface to the total catchment area.

Collecting System.—All sewers from the house to the outfall. See, also, **Sewerage System.**

Colloidal Matter.—Colloids or matter colloidal in character and action.

Colloids.—(1) The finely divided suspended matwhich will not settle and the apparently dissolved matter which may be transformed into suspended matter by contact with solid surfaces or preciptated by chemical treatment. (2) Substances which are soluble as judged by ordinary physical tests, but will not pass through a parchment membrane.

Combined Sewer.—A sewer designed to receive both storm water and sewage.

Combined System.—A system of sewers, in which sewage and storm water are carried in the same conduits.

Commercially Dry Sludge.—Sludge containing not more than 10 per cent of moisture by weight.

Common Sewer.—A sewer in which all abutters have equal rights.

Compartment.—A chamber in. or a division of, a structure for sewage treatment.

Concentrated Sewage.—A relative term. Sewage containing a relatively large quantity of organic matter.

Conditioning.—See **Sludge Conditioning.**

Contact Aerator.—A device consisting of a crate holding broken stone, coke, brushwood, or other media, which is placed in a single, or two-story sedimentation tank and through which the sewage is made to flow upward and return on the outside and become activated by the admission of compressed air below.

Contact Bed.—An artificial bed of coarse material, such as broken stone or clinkers, in a water-tight basin provided with controlled inlet and outlet. It is operated in cycles of filling with sewage, standing full in contact, emptying, and resting empty, in order to remove some of the suspended matter and oxidize organic matter by bio-chemical agencies.

Contaminated Water.—Water unfit for any given use because of contact with or the presence of injurious substances.

Contamination.—The introduction into water, otherwise satisfactory, of bacteria, sewage, or other substance, which makes it unfit for any given use.

Cover.—See **Manhole Head.**

Crown.—The inside top of a sewer.

Crude Sewage.—Sewage which has received no treatment.

Datum.—Plane of reference for elevations.

Degreasing.—The process of removing fats and greases from sewage, waste, or sludge.

Degree of Purification.—A measure of the removal and oxidation of the objectionable or putrescible contents of sewage.

Depressed Sewer.—A sewer, often crossing beneath a valley or a water course, which runs full or under greater than atmospheric pressure because its profile is depressed below the hydraulic grade line.

Detritus Tank or Chamber.—A detention chamber larger than a grit chamber, usually with provision for removing the sediment without interrupting the flow of sewage. A settling tank of short detention period designed, primarily, to remove heavy settleable solids.

Diffuser.—A porous plate or other device through which air is forced and enters the sewage in the form of minute bubbles.

Digestion.—The bio-chemical decomposition of organic matter resulting in the formation of mineral and simpler organic compounds.

Dilute Sewage.—A relative term. Sewage containing a relatively small quantity of organic matter.

Dilution.—(1) A method of disposing of sewage or effluent by discharging into a stream or other body of water. (2) The ratio of the volume of flow of a stream to the volume of sewage or effluent discharged into it.

Direct Oxidation Process.—(So-called.) A proprietary method of treatment in which sewage previously dosed with lime is passed through closed tanks between plate electrodes across which electric current is passing while the liquid is agitated by rotating paddles.

Disc Screen.—A screen in the form of a circular disc rotating about an axis perpendicular to its center.

Discharge Sewer.—See **Outlet Pipe.**

Disinfected Sewage.—Crude sewage, or a sewage plant effluent which has been treated with a disinfecting agent, commonly chlorine or "bleach," resulting in the destruction of bacteria sufficiently to reduce materially the danger of infection.

Disinfection.—The partial destruction, ordinarily by the use of some chemical, of the microorganisms likely to cause infection and disease.

Dispersion.—A method of disposal of the suspended solids in sewage or effluent by scattering them widely in a stream or other body of water.

Distributor.—A device used to apply sewage to the surface of a filter. There are two general types, fixed and movable. The fixed type may consist of perforated pipe or notched troughs, sloping boards, or sprinkler nozzles. The movable type may consist of rotating or reciprocating perforated pipes or troughs applying spray or a thin sheet of sewage.

Diversion Chamber.—A chamber which contains a device for diverting all or a part of the flow.

Diversion Manhole.—See **Diversion Chamber.**

Domestic Sewage.—Sewage derived principally from dwellings, business buildings, institutions, and the like. (It may or may not contain ground-water, surface water, or storm water. It may also contain a small proportion of industrial waste liquid.)

Door Thickener.—(Clarifier.) A proprietary device placed in a tank by which a system of scrapers, driven by a central shaft, revolves slowly, pushing the deposited sludge to a central outlet, from which it is removed by gravity or pumping.

Dortmund Tank.—A vertical-flow sedimentation tank with hopper bottom. The sewage, introduced near the bottom, rises and overflows at the surface, and the sludge may be removed from the bottom before it becomes septic.

Dosing Chamber.—See **Dosing Tank.**

Dosing Siphon.—An automatic siphon for discharging the contents of a dosing tank.

Dosing Tank.—A tank into which raw or partly treated sewage is introduced and held until the desired quantity has been accumulated, after which it is discharged at such a rate as may be necessary for distribution essential to the subsequent treatment.

Drain.—Conduit or pipe, usually underground, for carrying off, by gravity, liquids other than sewage and industrial wastes, and including ground or subsoil water, surface water, and storm water.

Drainage.—A general term for gravity flow of liquids in conduits. Commonly applied to surface and ground-water.

Drainage System.—A system of drains.

Drainage Water.—Water flowing in a drain derived from ground, surface or storm water.

Drop Manhole.—A shaft in which sewage falls from a sewer to a lower level.

Drum Screen.—A screen in the form of a cylinder or truncated cone rotating on its axis.

Dry-Weather Flow.—Flow of sewage in a sewer during dry weather.

Effluent.—Sewage, partly or completely treated, flowing out of any sewage treatment device.

Effluent Discharge Conduit.—See **Outlet Pipe.**

Ejector.—See **Pneumatic Ejector.**

Emscher Filter.—See **Contact Aerator.**

End Manhole.—One at the up-stream end of a sewer.

Entrance Well.—See **Inlet Well.**

Evaporation.—Vaporization of moisture from a wet surface.

Filtered Sewage.—The effluent of a sewage filter.

Filtering Medium.—The material through which sewage applied to a filter must pass.

Filtration.—(1) The process of removing suspended and colloidal matter from a liquid and the oxidation of its dissolved organic matter, by causing it to flow through a relatively fine porous medium. (2) Sometimes loosely applied to the removal of solids and liquid organic matter in treatment beds.

Filtros.—The trade name applied to an artificial porous stone made of carefully graded silicious sand by moulding, pressing, firing, annealing, and grinding. It is used as a filtering medium and for diffusing air in the activated sludge process.

Final Settling Basin.—A tank through which the effluent of a trickling filter, or other oxidizing device, passes for the purpose of removing the settleable solids before its discharge.

Final Settling Tank.—Same as final settling basin, but deeper and of less area.

Fine Rack.—A relative term, but generally used when the clear space between the bars is 1 in. or less.

Fine Screen.—A relative term, but generally used for a screen with openings ¼ in., or less, in least dimension.

Flaring Inlet.—A funnel-shaped entrance to facilitate flow into a pipe or conduit.

Flotation.—A method of collecting suspended matter in a tank as a scum at the surface by the evolution of gas by chemicals, electrolysis, heat, or bacterial decomposition.

Flowing-Through Chamber.—The upper compartment of a 2-story sedimentation tank.

Flush Tank.—A chamber in which water or sewage is accumulated and discharged at intervals for flushing a sewer.

Flushing Chamber.—See **Flush Tank; Flushing Manhole.**

Flushing Manhole.—A manhole provided with a gate so that sewage or water may be accumulated and then discharged rapidly for flushing a sewer.

Frame.—See **Manhole Head.**

Fresh Sewage.—Sewage of recent origin still containing free dissolved oxygen.

Gas Slot.—See **Gas Vent.**

Gas Vent.—(1) A passage to permit the escape of gases of decomposition. (2) An opening which allows gas, liberated in an Imhoff tank sludge digestion chamber, to reach the atmosphere without passing up through the sewage in the settling chamber.

Grade.—Elevation of invert.

Gradient.—See **Slope.**

Grating.—A screen consisting of parallel bars, two sets being transverse to each other in the same plane.

Gravity System.—A system in which all sewage runs on descending gradients from source to outlet, or where no pumping is required.

Grease Trap.—A device by means of which the grease content of sewage is cooled and congealed so that it may be skimmed from the surface.

Grit.—The heavy mineral matter contained in sewage, such as sand, gravel, cinders, etc.

Grit Catcher.—A chamber usually placed at the upper end of a depressed sewer, or at other points of protection on combined or storm-water sewers, of such shape and dimensions as to reduce the velocity of flow and thus permit the settling out of grit.

Grit-Chamber.—A small detention chamber or an enlargement of a sewer designed to check the velocity of the sewage enough to permit the heaviest solid matter, such as grit, to be deposited with a view to its frequent and easy removal. (Grit Compartment.)

Ground-Water—Water derived from beneath the surface of the ground.

Ground-Water Drain.—A drain which carries away ground-water.

Horizontal Flow Tank.—A tank or basin, with or without baffles, in which the direction of flow is generally horizontal.

House Connection.—See **House Sewer.**

House Sewage.—(1) Sewage from dwellings. (2) Loosely used for domestic sewage.

House Sewer.—A pipe conveying the sewage from a single building to a common sewer or point of immediate disposal.

Humus Sludge.—(1) Digested sludge deposited in final or secondary settling tanks, following trickling filters or other oxidizing device. (2) Sludge resembling humus in appearance.

Humus Tank.—A tank for collecting humus sludge. See, also, **Final Settling Tank; Final Settling Basin.**

Hydraulic Grade.—The elevation of the surface of the liquid in a sewer above an assumed datum.

Hydraulic Gradient.—The surface slope of the liquid in a sewer. Generally taken parallel to the invert.

Hydraulic Inclination.—See **Hydraulic Gradient.**

Hydraulic Slope.—See **Hydraulic Gradient.**

Hydrolysis.—A change in the molecular composition of matter produced by the addition of water.

Hydrolytic Tank.—In general, any sewage tank in which hydrolysis occurs, specifically applied to a special form of vertical flow tank. General term for any sedimentation tank in which, by bio-chemical processes, a part of the suspended organic matter is liquefied and gasified.

Imhoff Tank.—A deep two-storied tank invented by Karl Imhoff, M. Am. Soc. C. E., consisting of an upper or continuous sedimentation chamber and a lower or sludge digestion chamber. The floor of the upper chamber slopes steeply to trapped slots, through which solids may settle into the lower chamber. The lower chamber receives no fresh sewage directly, but is provided with gas vents and with means for drawing digested sludge from near the bottom.

Industrial Sewage.—Sewage in which industrial wastes predominate. See, also, **Domestic Sewage; Industrial Wastes.**

Industrial Wastes.—Liquid wastes from industrial processes.

Infected Water.—Water which contains pathogenic bacteria.

Infection of Water.—The introduction of pathogenic bacteria into water in sufficient quantities to produce disease.

Infiltration.—The leaching of water from the ground into a sewer.

Influent.—Sewage, raw or partly treated, flowing into any sewage treatment device.

Inlet.—A connection between the surface of the ground and a sewer for the admission of surface or storm water.

Inlet Well.—A well or opening at the surface of the ground to receive surface water which is thence conducted to a sewer.

Institutional Sewage.—Domestic sewage from institutions, such as hospitals, sanitariums, or penal and charitable establishments.

Intercepting Sewer.—A sewer which receives the dry-weather flow from a number of transverse sewers or outlets, with or without a determined quantity of storm water if from a combined system.

Intermittent Filter.—A natural or artificial bed of sand or other fine-grained material to which sewage is intermittently applied in doses and through which it flows, opportunity being given for filtration and also oxidation of the organic matter by bio-chemical agencies.

Invert.—Originally, the inverted arch of a masonry-lined sewer. By derivation, the floor, bottom, or lowest point in the internal cross-section of a sewer.

Invert Block.—A voussoir-shaped hollow tile built into the invert of a masonry sewer.

Inverted Siphon Sewer.—See **Depressed Sewer.**

Irrigation.—See, **Sub-Surface Irrigation; Surface Irrigation; Broad Irrigation; Sewage Farming.**

Junction Chamber.—A converging section of a sewer used to facilitate the flow from one or more sewers into a main sewer.

Junction Manhole.—A manhole at the junction of two or more sewers.

Kitchen Waste.—Liquid culinary wastes.

Lamp-Hole.—A small vertical pipe or shaft leading from the surface of the ground to a sewer, for admitting a light for purposes of inspection.

Land Drain.—A drain for drawing off water from land. See, also, **Ground-Water Drain.**

Lateral Sewer.—A sewer which discharges into a branch or other sewer and has no other common sewer tributary to it.

Leaching Cesspool.—A cesspool out of which the liquid leaches into the surrounding soil.

Line Manhole.—A manhole in the line of a sewer at a point where no other sewers connect. It may be at a point where the sewer changes direction, either in line, slope, or grade.

Liquid Sludge.—Sludge containing sufficient water to permit it to flow by gravity (ordinarily above 80 per cent).

MacLachlan Process.—(A Proprietary Process.) A method of conditioning sludge preparatory to dewatering by the application of sulfur dioxide gas.

Main Sewer.—A sewer which receives one or more branch sewers as tributaries.

Manhole.—A shaft, or chamber, from the surface of the ground to a sewer, large enough to enable a man to have access for the purpose of inspection and cleaning.

Manhole Head.—The cast-iron fixture surmounting a manhole. It is made up of two parts: A "Frame" which rests on the masonry of the shaft, and a removable "Cover." Frames are either "Fixed" or "Adjustable" in height. Covers are "Tight," "Ventilated," or "Anti-Rattling."

Medium Screen.—A screen having openings intermediate between those of a coarse and a fine screen.

Mesh Screen.—A screen composed of woven fabric, usually of wire.

Miles Acid Process.—A proprietary method of treatment invented by George W. Miles, in which sewage is acidified by sulfurous acid fumes. The fumes are absorbed by a part of the sewage. This part is then mixed with the remainder of the sewage. Subsequent precipitation of solids results in clarification and a measure of disinfection.

Outfall Sewer.—A sewer which receives the sewage from the collecting system and conducts it to a point of final discharge or to a disposal plant.

Outlet Pipe.—A pipe which conveys the effluent from a treatment plant to its final point of disposal.

Oxidation.—See **Sewage Oxidation.**

Oxidized Sewage.—Sewage in which the organic matter has been combined with oxygen and has become stable.

Percolating Filter.—See **Trickling Filter.**

Percolation.—The flow or trickling of a liquid downward through a relatively coarse filtering medium. The liquid usually does not fill the pores of the medium.

Plate Screen.—A screen composed of one or more perforated plates.

Pneumatic Ejector.—A means of raising sewage, or other liquid, by alternately admitting it through a check-valve into the bottom of a pot and then ejecting it through another check-valve into the discharge pipe, by admitting compressed air to the pot above the liquid.

Polarite.—Magnetic spongy carbon, formerly used as a filter medium after sedimentation.

Polluted Water.—Water made unclean or injured by sewage, industrial waste, or other substance.

Pollution.—The act of making unclean or impure or the state of being unclean or impure as a result of admixtures of sewage, industrial wastes, or other substance.

Precipitation.—Rain and snowfall. See, also, **Chemical Precipitation.**

Private Sewer.—One privately owned and used by one or more properties.

Public Sewer.—A common sewer controlled by public authority.

Putrefaction.—Biological decomposition of organic matter with the production of ill-smelling products. It occurs under conditions of oxygen deficiency.

Putrescibility.—(1) The susceptibility of waste waters, sewage, effluent, or sludge to putrefaction. (2) The relative tendency of organic matter to undergo decomposition in the absence of oxygen.

Rack.—A screen composed of parallel bars, either vertical or inclined, from which the screenings may be raked.

Radial Flow.—Direction of flow across a circular tank, from center to periphery, or vice versa.

Radial Inward Flow.—Inlet at periphery and outflow at the center of a circular tank.

Radial Outward Flow.—Inlet at center and outflow at the periphery of a circular tank.

Rainfall Rate.—Precipitation, generally expressed in inches per hour.

Rate of Precipitation.—See **Rainfall Rate.**

Raw Sewage.—See **Crude Sewage.**

Receiving Basin.—See **Inlet Well.**

Regulator.—A device for controlling the quantity of sewage admitted to an intercepting sewer or unit of a disposal plant.

Relative Stability.—The ratio, expressed in percentage, of available oxygen in waste waters, sewage, effluent, or diluted sewage to that required to provide complete bio-chemical oxidation of the organic matters contained therein.

Relief Sewer.—A sewer built to relieve an existing sewer of inadequate capacity.

Reservoir.—A tank or basin primarily for storage of a liquid.

Roof Water.—Storm water from roofs.

Run-Off.—That part of the rainfall which reaches a stream, drain, or sewer.

Run-Off Coefficient.—The ratio, expressed decimally, of run-off to precipitation.

Run-Off Rate.—An expression of the rate at which rainfall runs off from a surface, expressed in inches in depth of rainfall per hour, cubic feet per second, or other units.

Sand Catcher.—See **Grit Catcher.**

Sand Filter.—A filter in which sand is the filtering medium. See, also, **Intermittent Filter.**

Sanitary Sewage.—(1) Domestic sewage with storm water excluded by design. (2) Sewage originating in the sanitary conveniences of a dwelling, business building, factory, or institution. (3) The water supply of a community after it has been used and discharged into a sewer.

Sanitary Sewer.—A sewer which carries sewage and excludes storm, surface, and ground-water.

Saturation.—The condition of a liquid when it has taken into solution the maximum possible quantity of a given substance at a given temperature and pressure, as water saturated with oxygen.

Screen.—A device with openings, generally of uniform size, used to retain coarse sewage solids. The screening element may consist of parallel bars, rods, or wires, grating, wire mesh, or perforated plate, and the openings may be of any shape, generally circular or rectangular slots.

Screening.—The removal of relatively coarse floating and suspended solids by straining through racks or screens made of bars, gratings, wires, or perforated plates.

Screenings.—Material removed from sewage by screens and racks.

Scum.—A mass of sewage solids, buoyed up by entrained gas, grease, or other substance, which floats at the surface of sewage.

Scum Board.—A vertical baffle dipping below the surface of sewage in a tank to prevent the passage of floating matter.

Secondary Settling Tank.—See **Final Settling Tank.**

Sedimentation.—The subsidence and deposition of suspended matter in a liquid by gravity.

Sedimentation Tank.—A tank or basin in which sewage, partly treated sewage, or other liquid containing settleable solids, is retained long enough, and in which the velocity is low enough, to bring about sedimentation of a part of the suspended matter, but without a sufficient detention period to produce anaerobic decomposition.

Semi-Circumferential Flow.—Flow parallel to the semi-circumferences of a circular tank, divided at the inlet and meeting again at the common outlet.

Separate Sludge Digestion.—The digestion of sludge in basins or tanks to which it is removed from the basins or tanks in which it originally settled.

Separate System.—A system of sewers in which sewage and storm water are carried in separate conduits.

Sept-Aer-Sed Method.—Sewage treatment in which septic tank effluent is aerated and passed into a sedimentation tank. The sludge from the sedimentation tank is then pumped back into the septic tank.

Septic Sewage.—Sewage undergoing putrefaction in the absence of oxygen.

Septic Tank.—A settling tank intended to retain the sludge in immediate contact with the sewage flowing through the tank for a sufficient period to secure a satisfactory decomposition of organic solids by anaerobic bacterial action.

Settleable Solids—Suspended solids which will subside in quiescent sewage in a reasonable period. (Two hours is a common arbitrary period.)

Settled Sewage.—Sewage from which some of the solids have settled out in a tank during quiescence or slow flow.

Settling Chamber.—(1) The second or final element of the so-called biolytic tank. (2) Sometimes used to designate the sedimentation compartment of a 2-story tank, as in the case of the Imhoff tank. See, also, **Sedimentation Tank.**

Settling Solids.—See **Settleable Solids.**

Settling Tank.—See **Sedimentation Tank.**

Sewage.—(1) Wash water and water-carried animal, culinary, and, in some cases, industrial wastes. (2) Liquid waste containing human excreta, and other matter, flowing in or from a house drainage system or sewer. Excreta include feces, urine, secretion from the skin, expectoration, etc. (3) Liquid wastes from dwellings and institutions, stables, and business buildings. It may also contain liquid wastes from industries. (4) A combination of (a) the liquid wastes conducted away from residences, business buildings, and institutions, and (b) from industrial establishments, with (c) such ground, surface, and storm water as may be admitted to or find its way into the sewers. (5) The ordinary liquid contents of a sewer containing organic wastes, which may or may not include street wash.

Sewage Disposal.—General term. The act of disposing of sewage by any method.

Sewage Farming.—A term applied to the raising of crops where sewage is applied to the land for irrigation and fertilization purposes. See, also, **Broad Irrigation.**

Sewage Oxidation.—The process whereby, through the agency of living organisms in the presence of oxygen, the organic matter is converted into a more stable or mineral form.

Sewage Purification.—(1) The removal or mineralization of all putrescible organic matter and the removal of all infectious and offensive matter. (2) Loosely used for Sewage Treatment.

Sewage Treatment.—Any artificial process to which sewage is subjected in order to remove or so alter its objectionable constituents as to render it less offensive or dangerous.

Sewage Treatment Works.—Treatment plant and means of disposal.

Sewer.—A pipe or conduit, generally closed, but normally not flowing full, for carrying sewage and other waste liquids.

Sewer Appurtenances.—Constructions, devices and appliances other than the pipe or conduit, which are appurtenant to a sewer, such as manholes, flush tanks, surface inlets, etc.

Sewer Arch.—The curved top of a masonry sewer.

Sewer Outfall.—The structure at the lower end of an outfall sewer.

Sewer District.—The area deemed benefited by the construction and use of sewers.

Sewer Inlet.—See **Inlet Well.**

Sewer Territory.—See **Sewer District.**

Sewerage System.—A collecting system of sewers and appurtenances.

Sewerage Treatment Works.—See **Sewage Treatment Works.**

Sewerage Works.—Comprehensive term, including all construction for collection, transportation, pumping, treatment, and final disposition of sewage.

Sheffield System.—A method of activating sludge by the rotation of paddle-wheels placed at intervals in a long and relatively narrow and shallow tank.

Side-Walls.—The vertical, curved, or inclined walls which support the arch or top of a masonry sewer.

Simplex Process.—A process for activating sludge by the circulation of sewage up through a central tube, dispersing it by the rotation of an inverted cone suspended above, and permitting a downward return outside the tube.

Sink Water.—Liquid waste from a sink.

Skimming Tank.—A chamber so arranged that floating matter rises and remains on the surface of the sewage until removed while the liquid flows out continuously under partitions, curtain-walls, or scum boards.

Slant.—A branch inserted in a sewer for the purpose of making connection thereto.

Sleek.—The thin oily film usually present which gives characteristic appearance to the surface of water into which sewage or oily waste is discharged.

Slope.—The inclination of the invert of a sewer expressed in percentage of length, as a decimal, or as 1-ft. fall in a given length of feet.

Slot.—A narrow opening.

Sludge.—The accumulated suspended solids of sewage deposited in tanks or basins, mixed with more or less water to form a semi-liquid mass.

Sludge Bed.—Natural or artificial layers of porous material upon which sludge is dried by drainage and evaporation.

Sludge Cake.—A mass resulting from sludge pressing, or vacuum filtering.

Sludge Chamber.—See **Sludge Digestion Chamber.**

Sludge Compartment.—See **Sludge Digestion Chamber.**

Sludge Concentration.—Any process of reducing the water content of sludge which leaves it still in a liquid condition.

Sludge Conditioning.—Treatment of liquid sludge preliminary to, and to facilitate, de-watering.

Sludge De-Watering.—A general term for the removal of a part of the water in sludge by any process, such as draining, pressing, centrifuging, exhausting, passing between rollers, or acid flotation, with or without heat. It involves reducing from a liquid to a spadable condition rather than merely changing the density of the liquid (concentration) on one hand, or drying (as in a kiln) by high heat on the other.

Sludge Digestion.—The bio-chemical process by which organic matter in sludge is gasified, liquefied, mineralized, or converted into more stable organic matter.

Sludge Digestion Chamber.—(1) Any chamber used for the digestion of sludge. (2) The lower story of an Imhoff tank or Travis tank.

Sludge Drying.—The process of drying sludge by drainage or evaporation, by exposure to the air, or by application of heat.

Sludge-Drying Bed.—See **Sludge Bed.**

Sludge Pressing.—The process of de-watering sludge by subjecting it to pressure, the solids being retained, usually by a cloth fabric through which the water passes.

Spadable Sludge.—Sludge dry enough to be shoveled from the drying bed. (Ordinarily under 70 per cent moisture.)

Spiral Flow Tank.—A tank used in carrying out the activated sludge process in which a spiral motion is given to the sewage in its flow through the tank by the introduction of air through a line of diffusers placed on one side of the bottom.

Spray Nozzle.—See **Sprinkler Nozzle.**

Spraying Nozzle.—See **Sprinkler Nozzle.**

Sprinkler.—See **Sprinkler Nozzle.**

Sprinkler Nozzle.—A nozzle used for applying sewage in the form of a spray to a trickling filter.

Sprinkling Filter.—A trickling filter in which the sewage is applied by spray.

Squeegee.—A device, generally with a soft rubber edge, used for dislodging and removing deposited sewage solids from the walls and bottoms of settling tanks.

Stability.—The ability of any substance, such as sewage, effluent, or digested sludge, to resist putrefaction. (Antonym, Putrescibility.)

Stable Effluent.—A treated sewage which contains enough oxygen to satisfy its oxygen demand.

Stale Sewage.—Sewage containing little or no oxygen, but as yet free from putrefaction.

Stench Trap.—A flap in a frame which opens to admit cellar drainage to a sewer and then closes to prevent sewer air from entering the house.

Sterilization.—The destruction of all micro-organisms ordinarily through the agency of heat or of some chemical.

Sterilized Sewage.—A sewage effluent in which all micro-organisms have been destroyed.

Storm Drain.—See **Storm Sewer.**

Storm Overflow.—A weir, orifice, or other device for permitting the discharge from a combined sewer of that part of the flow in excess of that which the sewer is designed to carry.

Storm Overflow Sewer.—A sewer used to carry the excess of storm flow from a main or intercepting sewer to an independent outlet.

Storm Sewage.—Liquid flowing in sewers during or following a period of rainfall and resulting therefrom.

Storm Sewer.—A sewer which carries storm and surface water, street wash, and other wash waters, or drainage, but excludes sewage.

Storm Water.—Excess water during rainfall or continuously following and resulting therefrom.

Storm-Water Drain.—See **Storm Sewer.**

Storm-Water Overflow.—See **Storm Overflow.**

Storm-Water Overflow Sewer.—See **Storm Overflow Sewer.**

Street Sewer.—Common sewer or public sewer in a street. See, also, **Common Sewer: Public Sewer.**

Strong Sewage.—Sewage containing above the normal quantity of organic matter.

Sub-Drain.—A drain built beneath a sewer to intercept ground-water and prevent it from entering the sewer, especially during construction.

Sub-Grade.—The elevation of the bottom of a trench in which a sewer or drain is laid.

Sub-Main Sewer.—An arbitrary term for relatively large branch sewers.

Subsiding Basin.—See **Sedimentation Tank.**

Subsoil Drain.—A land drain deep enough to take water from the subsoil.

Sub-Surface Irrigation.—The process of sewage treatment in which sewage or effluent is applied to land by distributing it beneath the surface through open jointed pipes or drains.

Surface Inlet.—See **Inlet Well.**

Surface Irrigation.—The process of sewage irrigation in which sewage is applied to and distributed over the surface of the ground.

Surface Water.—Water which flows upon or over the surface of the ground.

Surface-Water Drain.—A drain which carries surface water.

Suspended Matter.—Solids physically suspended in sewage or effluent.

System of Sewerage.—See **Sewerage System.**

System of Sewers.—See **Sewerage System.**

Tank.—Any artificial receptacle through which liquids pass or in which they are detained during collection or treatment.

Tight Cesspool.—See **Water-Tight Cesspool.**

Tight Manhole Cover.—A manhole cover without openings.

Trade Wastes.—British expression for industrial wastes. See, also, **Industrial Wastes.**

Trap.—A device to prevent sewer air from backing up and escaping through a plumbing fixture. When made of cast iron or vitrified tile, it may be of various forms defined as running trap, P-trap, S-trap, etc.

Trash.—The material removed from combined and storm-water sewers by coarse racks.

Travis Tank.—A two-story hydrolytic or septic tank invented by Dr. Travis, consisting of an upper sedimentation chamber with steeply sloping bottom terminating in slots through which the deposited solids pass into a lower or sludge digestion chamber through which latter a predetermined part of the sewage is allowed to pass for the purpose of seeding and maintaining bacterial life in the sludge and carrying away decomposition products. This is for the purpose of inducing digestion of the sludge attended by its reduction in volume.

Treated Sewage.—Sewage which has received more or less complete treatment.

Trickling Filter.—An artificial bed of coarse material, such as broken stone, clinkers, slate, slats, or brush, over which sewage is distributed and applied in drops, films, or spray, from troughs or drippers, moving distributors, or fixed nozzles, and through which it trickles to the under-drains giving opportunity for organic matter to be oxidized by bio-chemical agencies.

Trunk Sewer.—A sewer which receives many tributary branches and serves as an outlet for a large territory. See, also, **Main Sewer.**

Twin or Multiple Dosing Tanks.—Twin or multiple tanks of equal capacity, each equipped with a dosing device, which devices are usually so inter-connected that they fill and discharge alternately, or in rotation.

Under-Drain.—A land drain laid below the surface of the ground, or of a sand filter or sludge bed. See, also, **Sub-Drain.**

Ventilated Manhole Cover.—A manhole cover with openings.

Vertical Flow Tank.—A sedimentation tank in which the sewage enters near the bottom, rises vertically, and flows out at the top.

Water-Tight Cesspool.—A cesspool with tight walls to prevent leaching and from which the contents are removed at intervals.

Weak Sewage.—See **Dilute Sewage.**

Wing Screen.—A screen in which the screening elements are radial planes or curved vanes rotating on a horizontal axis.

Method of Cleaning 37 Year Old Infiltration Gallery

During March and April, 1927, the wooden infiltration gallery, which was built in 1890 and used continuously for the subsequent 37 years as a main source of supply for the city of Newton, Mass., was scraped and thoroughly cleansed of growths and sediment. How this work was handled is described by William P. Morse, City Engineer, in his annual report for 1927.

During the time of cleaning the pumps at the Needham St. pumping station were shut down and all the water used in the city was taken by the Ward St. auxiliary station from the Metropolitan supply.

At two of the manholes, pumps were installed, pumping directly from the gallery and discharging into the river, by which means the ground water in the territory was lowered to grade 82.00, enabling the men to enter the gallery for the work of cleaning, the floor of the gallery being grade 81.00. The normal grade of the ground water outside the gallery was about 87.00. The grade of the Charles River is from 91.00 to 93.00.

The scraping down of the inside of the gallery was done by use of hoes with handles cut off to about 1 ft. in length and other types of scrapers and the materials thus removed, after falling into the 12 in. of water left upon the smooth plank floor was pushed by pushers or squeegees to the pumps and the whole pumped out into the river.

The materials found upon the sides, roof and floor of the gallery had been accumulating for 37 years and consisted of growths and deposits caused largely by crenothrix. These masses of material were found clinging to the roof and side walls of the gallery, forming a coating of from 2 to 6 in. in thickness, much of which, however, had fallen to the floor as the water was lowered by the pumping. The texture of the material was such as to permit of its being held in suspension in the water, and the masses disintegrated upon the slightest agitation. A grayish tinge seemed to be the predominating color.

This material was scraped off and the spruce and hemlock of which the gallery is built was found to be sound.

Manganese is also present in the ground water in the form of a mineral salt. Large quantities of a sand-like material composed of particles so very fine as to blow away in dust when dried, was found upon the floor in large lumps and coal black in color.

Very few of the tube wells which are connected into the gallery were found to be flowing.

The work inside the gallery was necessarily done under unfavorable conditions, but done in a very thorough and effective manner. The gallery is on a level grade and is 4 ft. square in the clear, inside, and about 3,800 ft. long, and is from 10 to 15 ft. underground.

The men were equipped with waist high duck hunter's rubber boots, oilskin coat and hat and a flashlight in addition to their scraping tools. As the water was maintained in the gallery at about 1 ft. in depth, there was left but 3 ft. of space in which to work. This naturally slowed down the work of cleaning somewhat.

Two electrically driven centrifugal pumps were used to hold the ground water down to this level, an 8-in. and a 10-in., with their suctions at the bottoms of the manholes. The manholes were built to a slightly lower level than the floor of the gallery.

Cement Gun Contractors Meet

The second annual meeting of the Cement Gun Contractors' Association was held at the Palmer House, Chicago, Feb. 18, 19 and 20.

Besides the election of officers for the ensuing year, important steps were taken for the improvement of the industry. A movement was started for the unification of the many patents covering various mechanical details and processes involved in Cement Gun work. When perfected, this will enable members of the association to give positive guarantees against patent infringement suits and it will so operate as to place a premium on quality instead of mere cheapness.

Steps were also taken to discourage unfair practices in bidding among members and to stop the practice among general contractors of shopping bids or of beating down Cement Gun prices after bids have been opened and contracts let.

Thirsty Rat Taps Water Pipe

A bill of $49.80 was recently paid by a cooperator of the Biological Survey of the U. S. Department of Agriculture for repairing the damage caused by one rat and its family. It was first noticed that water was dripping from the ceiling of a room directly under the bathroom, and then more than a square yard of plastering came down. The plumber who was called in had to move the bathtub and take up the floor to locate the trouble. He found that a rat had gnawed a hole about a quarter of an inch in diameter in the lead water pipe near the trap, apparently to quench its thirst. The constant drip from this little hole ruined the ceiling below. The householder invested immediately in a box of barium carbonate and a rat trap, and no more traces of rats have been found since this expensive visitation. The Biological Survey states that it is not at all an uncommon occurrence for rats to gnaw lead pipes or when thirsty to go long distances to get water.

Intakes in Lake Ontario for Water Supply of Hamilton, Ont.

Construction Features of New 60-In. Intake

By H. S. PHILIPS and JAMES STODART
City Engineer's Office, Hamilton, Ont.

THE city of Hamilton takes its water supply from Lake Ontario, and by means of a pumping plant forces it five miles to the center of the city. It is distributed over 8,800 acres to a present population of 134,500, and by further pumping is raised to two additional levels.

The annual consumption for 1927 was 6,420,691,500 gal. This represented an average per capita consumption of 138 gal. In the year 1913, the annual consumption was 3,661,893,300 gal. with a consumption of 99.5 gal. per head per day.

The waterworks system of the city of Hamilton was originated in 1859, and took its supply at that time from a rectangular excavation, (now 3,000 ft. long), parallel with the shore of the lake, referred to on the plans as the "infiltration basins," and connected to a pumping station, 1,900 ft. distant, by a 33-in. diameter wood stave conduit.

The rate of inflow by filtration gradually diminished, and in 1889 a 20-in. diameter cast iron intake pipe with wooden crib was laid from the basins 880 ft. into the lake, the depth of water at the inlet being 20 ft.

To provide for increased water consumption, the size of the infiltration basins was increased in 1901. At that time a 36-in. diameter wood stave pipe was laid from the interior of the basins to the lake shore line. This was intended for future extension into the lake, but was never utilized.

In 1913, a 48-in. diameter steel intake was laid 2,144 ft. into the lake, the depth of water over the crib inlet being 33 ft. A 48-in. diameter concrete conduit was also laid to convey the water from the basins to the pump house.

In February 1923, a short but almost total interruption to the city water supply occurred when the flow in the 48-in. diameter intake was blocked by ice. To reduce the risk from further ice trouble, and to provide greater intake capacity, a new 60-in. diameter intake and conduit was recommended in 1926. It was also recommended that the infiltration basins be abandoned and the 48-in. intake and 48-in. conduit joined up. As the intake and conduit entered and left the basins 1,200 ft. apart, the construction of the 48-in. connecting conduit became a major operation.

No trouble has been experienced at Hamilton with the intake pipes on account of scour or deposits on the lake bottom. The 48-in. intake was inspected by divers in August 1923, and from their report everything checked up with conditions as known to exist when the pipe and crib were laid in 1913. Soundings taken in the vicinity show that there has been very little change in the lake bottom for at least 4,000 ft. out from shore, and at the location of the crib this agreed with the divers' report.

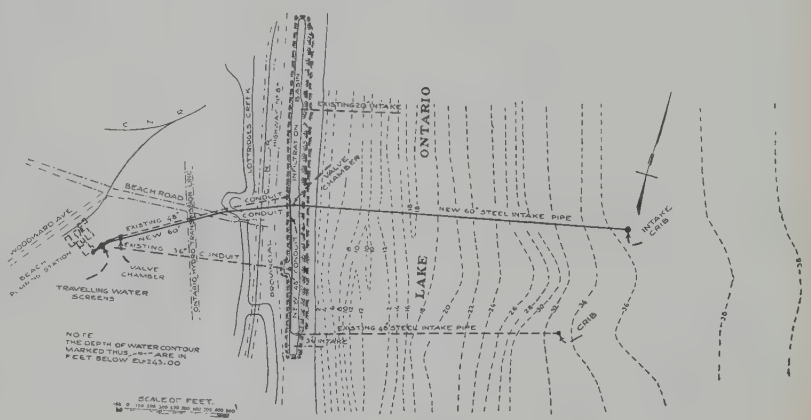


Fig. 1—General Plan Showing Location of the Various Intake Pipes

Laying the 48-In. Intake.—In 1912 the first pipe for this intake was laid in the infiltration basins, and work carried on outwards into the lake. The equipment used consisted of a scow fitted with a derrick and clam shell for excavating, and pipe lowering equipment at each end, a pile driving scow, and steam tugs. The bearing piles were first driven, and then sufficient trench was dredged out for one pipe length. Bearing piles were then cut to grade and capped, and the pipe lowered from the bottom of the scow. All trench was backfilled after the pipe had been laid. The wooden crib was built on shore, floated out to position and placed. Two expansion joints were used on the line, and wedge-shaped wooden gaskets used for changes in grade. The 48-in. riveted steel pipes were 142 ft. long, delivered on the lake shore in lengths of between 20 and 30 ft. and assembled to the required length.

New 60-In. Intake.—The new 60-in. intake is laid beneath the bed of the lake approximately 1,100 ft. west of the 48-in. pipe, and has its intake bellmouth 3,000 ft. out from the present infiltration basins. It is concreted from the valve chamber through the bank of the infiltration basins and for about 430 ft. out from the shore line.

The steel pipe consists of 23 lengths, each about 126 ft. long, and one closing length. The material used in the pipe is open hearth tank plate steel ½-in. thick. The longitudinal seams are double riveted, with single riveting on the circumferential seams. All rivet holes were punched $\frac{7}{8}$-in. small and reamed out to full size after the plates were assembled and bolted in place. Punched holes which did not coincide to within ⅛-in or less were reamed out to $1\frac{3}{16}$-in. and 1⅛-in. rivets used. Consideration was given to pipe with electro-welded butt joints, but no tenders on this method of construction were received.

The flanges are 5 by 4 by 1 angle iron riveted to pipe and faced and drilled for 36 1-in. diameter bolts with lock washers and hexagonal nuts. The pipes were coated with a solution of coal tar pitch and linseed oil applied hot.

Five cast iron flexible joints were included in the pipe line to allow for change in grade, settlement, etc. Two expansion joints were also included to facilitate joining up the closing lengths and are shown in detail in the accompanying illustration.

The intake crib is constructed of interlocking steel sheet piling shell 22 ft. in diameter, consisting of arch web section 40.83 lb. per lineal ft. At the center of this shell, a steel cone is connected to the intake pipe by a cast iron

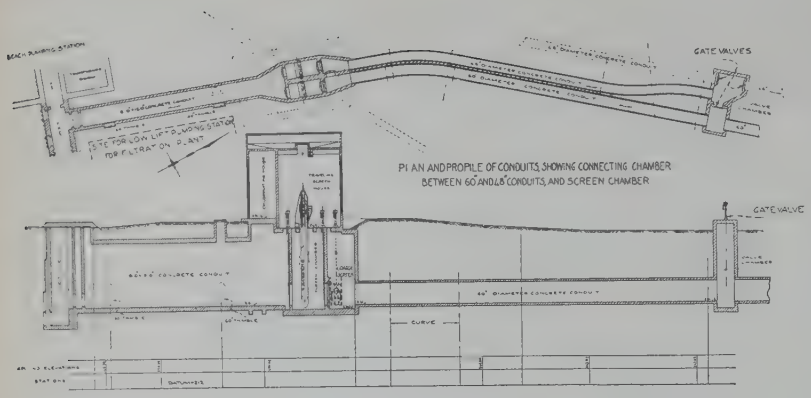

GATE VALVES
PLAN AND PROFILE OF CONDUITS, SHOWING CONNECTING CHAMBER BETWEEN 60" AND 48" CONDUITS, AND SCREEN CHAMBER
GATE VALVE

Fig. 2—Plan and Profile of Conduits Showing Connecting Chamber Between 66-In. and 48-In. Conduits and Screen Chambers

elbow and concreted as shown on drawings.

A reinforced concrete baffle plate, above the opening, anchored by 3-in. diameter manganese bronze bolts, prevents the warm surface water being drawn directly down into the pipe in the summer, and in winter time obviates danger from downward currents carrying slush ice into the intake.

Intake Velocities.—Velocities in the intake openings have been kept to a minimum to reduce the hazard of frazil ice formation. The six intake ports have an area of 54 sq. ft., giving a velocity of 1.45 ft. per second at time of ultimate maximum draught. As the demand is greatest in the summer months, the winter velocities should always be lower than those above stated. Other ultimate demand intake velocities are: orifice, 1.18 ft. per second; throat, 2.8 ft. per second, and in the 60-in. diameter pipe, 4.7 ft. per second.

Each of the 23 sections of the intake is supported on three pile bents, with rolling blocks bolted to the cap. Where the fill is more than 6 ft. deep, the pipe is encased in 1:3:5 concrete 12 in. thick.

The lengths of 60-in. steel pipe were fabricated at the East End plant of the Hamilton Bridge Works, loaded on cars and placed in the water at Hamilton harbor by means of locomotive cranes. From the harbor they were towed by motor boats across the bay, and beached on the lake shore adjacent to the site of the work. From this point they were handled by the laying contractor.

Construction Methods.—When construction on the 60-in. intake was commenced in June, 1927, the water supply for the city was taken through conduits from the infiltration basin, which was fed by the lake intakes previously referred to. In order that this supply should not be contaminated or interfered with in anyway, steel piling was driven on each side of the line of the pipe from the coffer dam, in which the intake valve house was being constructed, to the lake side of the basins. Dredging was then commenced in the lake for the third length of pipe, and also on land, cutting through the bank between the basin and lake.

Dredging was carried out continuously in the lake by a dipper dredge. The pile-driving scow followed up the dredge, driving the bearing piles, and behind it came the diver's scow placing caps.

The pipes were laid from the side of a barge fitted with steam winches and two outriggers, concrete counter weights being used on the opposite side for trimming. When everything was ready for pipe laying the barge was brought into line and correct position and bulkheads were removed. The pipe was then lowered on the bents and faced up. The flanges were next bolted by divers in from two to three hours and the rolling blocks secured. During the entire operation the pipes were held by the slings from the outriggers.

Where the pipe is encased in concrete, pouring was done from a scow fitted with a mixer, concrete being placed in forms through tremie pipes. Forms were built with angle iron bracing and lined with 2-in. sheeting. Steel distance plates, which rode the top of the pipe, were fixed to the top horizontal braces to ensure the proper vertical position of forms and also the proper depth of concrete.

Bearing piles were driven 15 ft. below grade of pipe, and to shale where the latter was encountered.

The outside steel sheeting for the crib was assembled as a unit on board a scow, and an opening left in the side wall sufficiently large to straddle the 60-in. intake pipe. The crib was floated to position and lowered by means of a derrick scow. The structure rests on a levelled-off shale bottom. All openings in the crib were then formed up and concreting completed. The baffle plate, anchor bolts for which were left in the crib, was then placed in position.

When pipe laying had progressed far enough from shore to permit sufficient room for working advantageously, backfilling of trench was commenced, and continued for some time after the remainder of the work was finished, being completed about the first week of December, 1927.

At the junction between the steel intake and 60-in. diameter concrete conduit in the middle of the existing in-

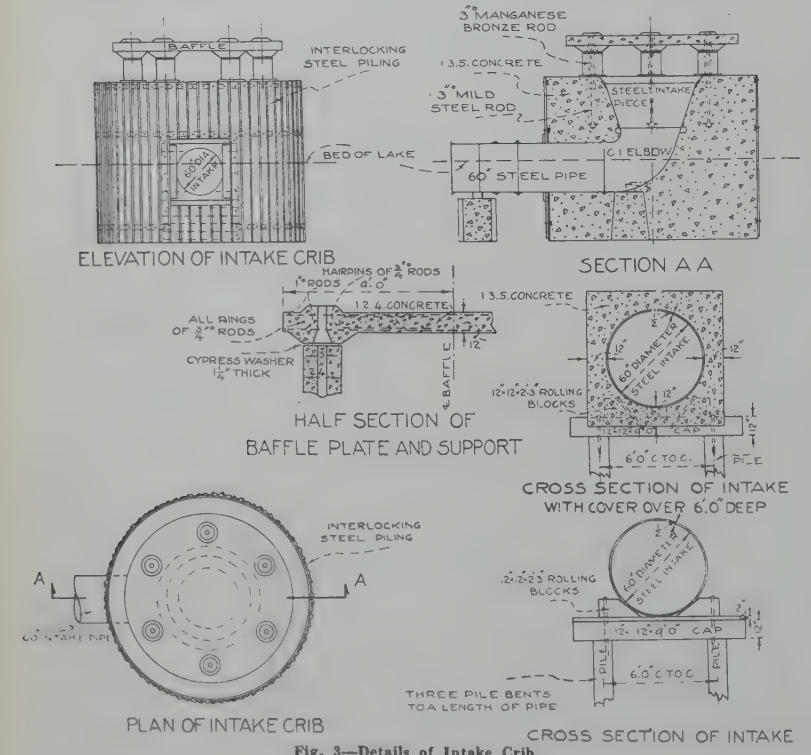


Fig. 3—Details of Intake Crib

filtration basins, a chamber was built containing a penstock on the entrance to the conduit.

60-In. Conduit and Screen House.—Work on the 60-in. conduit was commenced at the pumping station end, and proceeded with towards the infiltration basin. Excavation was done by a Bear-cat excavator, good clay being encountered until the east side of Lottridge inlet was reached. At this point the clay dropped off almost vertically and heavy water bearing gravel was encountered. Considerable difficulty was experienced in this section of the work, the trench having to be sheeted with steel sheet piling and bulkheaded.

The 60-in. diameter conduit consisted of lock joint pipe jointed in the ordinary manner with cement, and bedded in concrete to springing line.

Immediately before entering the suction well at the pump station, the water passes through traveling water screens, erected in duplicate. The existing 48-in. conduit was cross-connected with the 60-in., so that the supply from both conduits is screened.

The use of penstocks in the screen and valve chamber permits the whole supply to be dealt with by one traveling screen, while the other is out of use. The screens are 6 ft. wide with ¼-in. mesh and operate at a speed of 11 ft. per minute. Two cast iron flanged thimbles 60 in. in diameter were built into the main conduit to provide future connections to a low lift pumping station when a filtration plant is constructed.

The chlorinating house was built in conjunction with the screen house and provision made for duplicate chlorinating apparatus and weigh scales.

Laying Connection Between Old 48-In. Intake and Conduits.—The joining up of the existing 48-in. diameter intake and conduit was accomplished by use of 48-in. lock joint concrete pipe laid in the banks of the basins. Monolithic concrete was used on the curves. Pile bents, 4 ft. on centers, were used under the monolithic section crossing the east end of the basin.

This conduit was laid after the 60-in. intake and conduit were put in operation, and the infiltration basin was no longer required for the city water supply. The pipe was laid approximately 11 ft. below the elevation of the water in the basin, but it was found possible by closing the existing intakes to keep the water below invert grade by means of the pumps at the waterworks pumping station, and the pipe was laid in the dry.

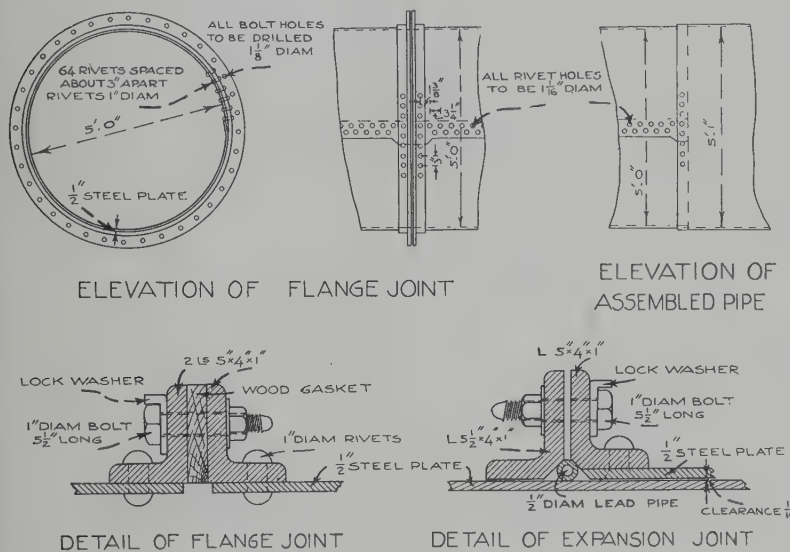


Fig. 4—Details of Flange Joint and Expansion Joint

The conduit was joined to the existing 48-in. pipe which had been laid in 1913. The first 112 ft. of the latter were of steel pipe, and when this was cut into it was found to be in an excellent state of preservation.

On the completion of the maintenance period, the entire work was inspected and was found to be in a perfectly satisfactory condition.

Acknowledgment.—The above paper was presented Feb. 15 at the annual meeting of The Engineering Institute of Canada.

Regional Planning for Kansas City.—Steps are under way for a regional plan for Kansas City. The plan involves six counties, three in Missouri and three in Kansas, and includes an area with a population of 750,000. The aims of the regional plan here are extensions of zoning regulations into the suburban area, setting aside areas for homes, parks, playgrounds, public buildings, commercial and industrial buildings, co-operation in building of highways, police protection, sanitation, construction of sewers, and maintenance of water supply.

Improvement in Utilization of Fuel by Public Utilities Continued During 1928

Preliminary figures of the U. S. Geological Survey of the total annual production of electricity by public utility power plants in the United States indicate an output of 87,851,000,000 kilowatt-hours in 1928, an increase of nearly 10 per cent over the output for 1927.

Water power was used to generate 34,747,000,000 kilowatt-hours, or about 40 per cent of the total current. Water power has generated more than one-third of the electricity produced by public utility power plants every year from 1919 to 1928. During the past four years the output by water power has increased more rapidly than the output by fuel power, and in 1928 the output would have been more than 40 per cent attained but for the abnormally dry weather in the later part of the year, which reduced the water supply of the streams used for power.

The amount of electricity generated by the use of fuels was 53,104,000,000 kilowatt-hours, or 60 per cent of the total. Of this amount, coal was used in the generation of 88 per cent, gas 7 per cent, oil 4 per cent, and wood less than 1 per cent.

Public utility companies and their power plant operators were again successful in increasing the efficiency in the utilization of fuels in the generation of electricity. The amount of electricity generated by the use of fuels in 1928 was 5.5 per cent more than in 1927. The amount of fuel consumed, however, was only 1.1 per cent more than in 1927. The increase in output was therefore five times as much as the increase in the amount of fuel consumed. The average rate of fuel consumption for the entire United States in 1927 was 1.84 lb. of coal per kilowatt-hour; in 1928 the rate was reduced to 1.76 lb., a reduction of 0.08 lb., or about 1¼ oz., per kilowatt-hour. This small saving per kilowatt-hour in generating the 53,000,000,000 kilowatt-hours of fuel-generated electricity, however, amounted to 2,120,000 tons in the year, which equivalent to about $8,000,000. In 1919 the average rate of coal consumption in generating electricity was 3.2 lb. per kilowatt-hour. The rate of 1.76 lb. for 1928 is therefore very close to half the 1919 rate. If coal had been consumed by electric public utilities at the rate of 3.2 lb. per kilowatt-hour in 1928 the increase in fuel consumption would have been about 38,000,000 tons, representing about $150,000,000.

Southeastern Water and Light Association.—The next convention of this association will be held April 15, 16 and 17, 1929, at Birmingham, Ala.

Municipal Research and the City Manager

How Research Bureaus Can Aid the City Manager

By STEPHEN B. STORY
City Manager, Rochester, N. Y.

I AM going to speak disjointedly and without plan or framework on which to hang my meagre thoughts—it violates all my research training, but it is the best I can assemble between negotiations with a bridge engineer for a bridge design, an argument over the amount a cemetery should pay upon a pavement to be used by a greater proportion of joyriders than hearses, a newspaper story on a new municipal golf course, a radio talk on Rochester products, a discussion on how to get more business for the subway, an interview with the city hall superintendent concerning cockroaches in my roll top desk, a meeting with a delegation of ladies who want a speech on recreation, a brief talk with a serious young man who wants a ginger story magazine suppressed, a dictated letter complimenting a cop on the occasion of his getting the draw and crippling a gunman armed to the teeth, a report on the progress of the indictment of a paving grafter, a delegation of barbers with an exhibit of dirty towels used by scab barbers, a few dozen telephone calls and a hell of a fine day for golf.

At the outset I must state that my remarks do not apply to the city manager who is looking at his job solely as a means of livelihood. Thank fortune this type of manager is scarce and is growing scarcer. This type of manager is little interested in improving the quality of government and is quite out of sympathy with, and beyond the aid of assistance of any agency interested in so-called better government. Having eliminated from discussion this type of individual, I want to suggest that in respect to their objectives there is no fundamental difference between the city manager and the researchers. They are both striving to make better their local government—if both succeed the livelihood proposition will take care of itself.

The research bureau men go at their jobs a bit differently from the city manager. The researchers can proceed leisurely and unhurriedly along a fairly even course, while the city manager has to move rapidly and swiftly upon some matters and slowly upon others. The bureau men work indirectly and endeavor to impress their ideas upon others while the city manager has to act directly and stand the full gaff. The research worker is detached from the actual job while the city manager has his nose stuck right into it. The researcher has time to reflect upon, and study his problem, but the city manager and his department heads know all the sensations of the chap who is juggling the cut glass pitcher, the lighted lamp, the feather and the 8-lb. dumb-bell, and who may get caressed by a hornet just overloaded with animosity.

Important Difference Between Researchers and City Managers.—There is another important difference between the workers in the research bureau field and the city manager. As one who has passed from the realm of preaching to the realm of practicing, I feel that I am in a position to recognize this fundamental difference. The researcher,—and, by the way, I am using the word "researcher" for the sake of brevity, meaning it to include all of the men who are working in research bureaus or perhaps, properly defined, those who constitute the Governmental Research Association—the researcher has no responsibility whatsoever. He is responsible for neither men, materials nor money. The directors of the bureau, of course, have a limited responsibility in this respect. On the other hand, the city manager is weighed down with a tremendous responsibility and the greater the centralization of power granted the manager under his city charter, the greater is his responsibility. As I look at it, there is nothing in the research game which accelerates a crop of gray hair beyond the ordinary ravages of time, while the city manager gets a few more every time the postman calls, the council meets, or the telephone rings. A budget preparation season ought to be good for a snow white thatch for any city manager and his department heads. I say this with all deference to the researchers and it is offered in the light of several years' experience in the research field and but a few months in the manager field.

It has always been my personal feeling that a research bureau could not function successfully as a part of the official government organization. The chief reason for this feeling is that the research bureau must have complete independence and detachment from the official organization which it is assisting or criticising. If a research bureau is dependent upon the executive or city manager for appointments of personnel, for fixation of salaries, for advancement or for bureau budgets, the very natural and human tendency is to cushion criticism and to "yes" those responsible for funds and for appointments. I feel that complete independence is absolutely essential; and it looks as though it could be obtained only by having the research bureau supported by other than public funds and by having its staff responsible to an independent board of high type trustees. Although I have suggested independent support and control, the city government and its city manager need an agency of the research bureau type. Ordinarily the city manager and his department and bureau heads have their time so completely absorbed by routine departmental and bureau duties and by contact with the public that nothing in the nature of research work can be done.

From observation and personal experience, I know that after putting in a full day the average city official has little energy and little zest to undertake anything in the nature of research, and, incidentally, most city officials have families who have some sort of lien upon their spare time.

Some of the Functions of a Bureau.—There are problems arising within the city organization almost every day which need the consideration and study that a research bureau alone can afford. I dare say that there are enough problems that will suggest themselves in Rochester within the next year, which, if turned over to the Rochester Bureau for solution, would absorb the entire time of that bureau for the next five years. Bureaus and city governments tackle those problems which appear to be capable of solution within a reasonable time, but gloss over many of the others because of their seeming impossibility of solution. I believe that all these problems could be solved if the time could be found to put upon them.

There is another function which a research bureau properly can undertake and which can be of tremendous service to the city manager. That is the function of a critic of the administration. Like all governmental administrations, the city manager form of government usually has two kinds of critics: first, those who are politically opposed to the city manager idea and possibly to the council in power and who criticise with an undoubtedly biased point of view; and second, those who favor the city manager form of government and the council group which is in the majority. These last are apt to find little to criticise in the activities of the government. Criticism from enemies is not worth much beyond serving to keep an administration on the alert, and, equally so, criticism from ardent admirers is not worth much because of it "yes, yes" character. How-

ever, no thinking city manager can afford to blind himself to the desirability of having a critic whose criticism is fair, just and constructive and whose objective is, or should be, essentially the same as that of the city manager; namely, in seeing to it that the government delivers to the people of the city the highest type of service to be obtained. A bureau should have no ax to grind, and its disagreements with the administration should be perfectly friendly. Above all, it should be patient. The bureau which rushes into print with its criticisms of the manager for the sake of bureau advertising should receive but little consideration from the manager. If the manager's objectives, because of political expediency or a defective charter, are not coincident with those of the bureau, and the two are not working toward the same end, they had best not be friendly and not work together.

Appraisal of Results.—At all times the city manager and the taxpayers should be eager for an appraisal of results or of accomplishments. The city manager usually is not in a position to appraise these results and, even if he should be, his appraisal, if flattering, is liable to be condemned by his enemies, and if unfavorable, is magnified as an admission of weakness. Under any circumstances, self-appraisal is not acceptable as being biased and not in good taste. The appraisal of results can best be made by a bureau possesed of all its independence and detachment.

There is another way in which a bureau can be of great value to the manager. There are many times when the manager has to do something which, though right, just and proper, is unpopular and imperfectly understood. It takes a bit of courage under less circumstances. Maybe the council is not on the right track and the manager has to disagree with it—the pepole to whom he has to look for his job—he has to drive hard to get them to do the right thing. Then is the time when he needs encouragement, the little word of approbation which helps him to stick it out and finally get results. The bureau can do this. It does not have to shout, far from it—all he needs to know is that some clear thinking group agrees with him. It does not take much to help one over a rough and stony road.

The research bureau can further aid a city manager by acting as one of his ears. I think that, if the proper tactics are used, a research bureau can find out through different channels and can report to the city manager the feeling of the man in the street and of Mr. and Mrs. J. Taxpayer concerning the government or some of the things it is doing. Curiously enough, I have found that the surface indications which we get at the City Hall register two extremes. The report that everything is rotten comes from the knockers and kickers who drop in to vent their spite. On the other hand, the administration is the most wonderful ever in the words of those who are seeking jobs, favors or concessions. Our great need is for information which is clear and undistorted about the public's attitude on questions. Why is not reading the public pulse one of the proper activities of a bureau in its service to the city manager?

Cooperative Work.—The research bureau should be a staff agency to the city manager and as such its work must be highly cooperative. I want to make the observation that once a bureau decides to act as a staff agency for the city manager, or for any city administration, it must continue to act in that capacity without regard to the personality of the manager. Once it has put its hand to the wheel it must keep it there. It cannot be cooperative with one city manager and militant with his successor. If it gets into close relationship with the manager it almost automatically becomes a part of the administration. It must sink or swim with it.

As much tact is required on the part of the bureau workers under the close relationship which I have indicated as under a situation where the bureau has to be militant in order to get results. It must guard its relationship carefully and bear in mind that it is contacting with hard worked men who are striving to produce results, and who, because they are giving 100 per cent of their ability and time to the job, are sensitive and touchy to bureau suggestions. The bureau must be careful never to substitute itself for those who are carrying the real responsibility. The city manager, with whom the bureau is acting as a staff agency, has a responsibility to see that the proper balance is maintained between the bureau and his men.

A bureau must be patient. Just because they are working in close cooperation the researchers can easily become impatient for results. It is often not expedient to do a certain thing at a certain time, or perhaps the manager or his department head may not have had time to study the problem.

Personally, in Rochester, I have felt that my job as city manager was simply an extension of bureau work—I have only moved nearer the firing line. When Baker and Higgins left the Rochester Bureau to enter the city's service we never felt that they had left us—they were going to carry on as bureau men working for better government. I humbly hope that I can maintain my ideals of government and can carry them out in practice.

Probably I am biased in my ideas about close relationship. If I am, just lop off a fair discount from what I have said.

Acknowledgment.—The above is taken from a paper presented at the 17th annual meeting of the Governmental Research Association.

Group Insurance for City Employees

The Plan Adopted by the City of Kenosha, Wis.

By P. J. HURTGEN
Director of Public Works, Kenosha, Wis.

NO part of a city's business should receive more thought today than the problem of maintaining the good will and cooperation of the employees. The value of public good will has long been recognized and very frequently capitalized. No plan has done more toward maintaining that personal touch in our city management and securing the loyalty of the employees and the employees' families than has our plan of Employees' Insurance.

The Plan.—Our plan of insurance provides protection for the family of a deceased employee during the period of readjustment following the death of the wage earner. It does away with passing the hat at the death of an employee and puts on a business basis what was formerly taken care of through charity. It provides employees with insurance protection that many could not get otherwise.

Unless your employees are better protected than the average, and I am certain they are not, you will find about 10 per cent that are adequately insured, 30 per cent with inadequate protection and 60 per cent with little or no protection. The U. S. Chamber of Commerce estimates that 20 per cent of the working men cannot get insurance because of physical impairments.

Employees' insurance is issued without a medical examination, except in a few states whose statutes require a brief medical inspection. Insuring your employees relieves them of some of their worries and creates in them a spirit of cooperation.

The Cost.—The cost of employees' insurance is small: about 3 ct. a day per employee, gives each of your employees $1,000 insurance. The exact cost is determined by the average premium based on the age of the employees. The rate of 3 ct. per day applies to those employees under 56 years of age. After the age of 56 years is attained, the coverage drops to $500 with the premium remaining the same.

Under the plan effective in Kenosha, heads of departments are entitled to carry 2½ times as much insurance as other employees. In order to procure insurance for your employees, you must interest 75 per cent of the employees to become subscribers to the insurance.

Amount of Average.—There are several plans of insurance offered by the various insurance companies. The amount of the coverage for your employees should not exceed an amount that can conveniently be financed by the low salaried employees. When the insurance plan was discussed by the

employees of our city, it was voted and agreed that all employees who had not attained the age of 56 years would take coverage in the amount of $1,000 and those who had attained the age of 56 years $500, with the understanding that heads of departments could later apply for and receive 2½ times the above amounts, and after the plan went into effect, the department heads who wished the additional insurance applied for and received the additional amount. Under our plan the amount of insurance for which each employee is to be insured is determined by class as follows:

Class 1. Employees who have not attained their 56th birthday, other than department heads $1,000
Class 2. Employees who have attained their 56th birthday, other than department heads 500
Class 3. Department heads who have not attained their 56th birthday..... 2,500
Class 4. Department heads who have attained their 56th birthday..... 1,000

However, if the employees in Class 1 had felt able to meet the premium on a $1,600 policy, they would have been free to select a policy up to that amount, and then in that case, the department heads would have been eligible to insurance up to $3,000.

However, the amount of the insurance must be based on some plan which precludes any individual determining what amount of insurance there will be on his life. This must be determined by the group of which he is a part.

Maximum Insurance Obtainable.—The maximum insurance obtainable for department heads is $10,000, and employees not department heads, $4,000. To obtain these maximum amounts the total coverage on all employees must be not less than $1,500,000 and this amount of coverage could easily be obtained in the large cities where many employees are carried on the pay roll.

Employees who have reached the age of 80 years are not eligible for insurance.

Inasmuch as a man's rating per $1,000 insurance at:

25 years of age is	$ 0.54	monthly
35 years of age is	.58	monthly
45 years of age is	.86	monthly
55 years of age is	1.71	monthly
60 years of age is	2.52	monthly
65 years of age is	3.76	monthly
70 years of age is	5.61	monthly
80 years of age is	12.20	monthly

and if you include firemen and policemen in your group, there is an extra rating of 25 ct. per month on each.

As the employees' rating, as a group, will be based on the above average rating, it becomes apparent that the lower the average age of the group, the lower the monthly premium will be, and to bring this rate down to a fair average, especially where there are many old men, it is recommended to give the oldest men half the amount of insurance at age 56, for the need of insurance for an old man is not in proportion to that of the young man, who has responsibilities, such as establishing a home, small children, etc., whereas an old man's responsibilities are mostly confined to taking care of his wife.

When the Employee Leaves.—In case the employee leaves the employ of the city during the continuance of his insurance coverage, the employee may, if he applies for insurance within 31 days of termination of his employment, be entitled to have issued to him without medical examination and upon payment of the premium for his then attained age, a contract of life insurance in any one of the forms customarily issued by the company, except term insurance.

Permanent and Total Disability Benefit.—If an employee while insured and before reaching his 60th birthday becomes wholly disabled by bodily injuries or disease, and will be permanently, continuously and wholly prevented thereby for life from engaging in any occupation or employment for wage or profit, no further premium will be collected and the amount of his insurance will be paid to him in a fixed number of installments chosen from the following table:

Number in Years During Which Installments Will Be Paid	Amount of Each Installment Payment for Each $1,000 Insurance	
	Annual	Monthly
1		$85.00
2	$509.00	43.27
3	345.00	29.33
4	263.00	22.36
5	214.00	18.19
10	116.00	9.86
15	84.00	7.14
20	68.00	5.78

Under the Kenosha plan, a man must have been in the continuous employment of the city for a period of six months to be eligible for insurance and must apply for insurance within 90 days after date of eligibility.

How Group Insurance Is Handled at Kenosha.—This whole plan of Employees' Insurance is in reality what insurance companies term "Group Insurance." Group insurance can only be written in cases where the employer pays at least two-thirds of the premium. Under existing state laws, few, if any, cities are authorized to expend taxpayers' money for such purposes, this being true in Wisconsin and wishing to give our employees the benefit of wholesale insurance, we organized the Mutual Benefit and Insurance Association of the Employees of the City of Kenosha. Two-thirds of the premium is paid by the employees into the association, the association in turn issues to the city a check by the association's treasurer equal to the two-thirds which the employee is required to pay, and the city then forwards to the insurance company the amount deducted from employees and in addition, a check for the exact amount received from the association. The entire transaction is handled by the city and thus the employee is put to no trouble whatever in taking care of the premiums.

The city council by resolution authorized the city treasurer to receive and disburse these funds as above outlined. In presenting this subject, I have outlined the plan adopted by the city of Kenosha. There are several other plans offered by insurance companies that may fit in better with local conditions in the many cities represented here. Your local insurance representatives can best work out with you the plan that will give you and your employees the best protection for the money expended. You, at least, owe it to your faithful employees to offer them some plan of protection and give them an opportunity to make full use of it if they so desire.

Acknowledgment.—The foregoing is taken from a paper presented before the Wisconsin Section of the American Water Works Association.

Municipal Forest Planted in 1896 Paying for Itself

As far back as 1896 the city of Little Falls, N. Y., was purchasing lands with the view of ultimately controlling the watershed of the neighboring Spruce and Beaver Creeks. Today the water supply of this city of 14,000 population is protected by municipal ownership of 4,003 acres of land at the headwaters of the two creeks, writes R. R. Fenska of the New York State College of Forestry.

Up to 1927, 1,200 acres of mature timber was in a very nearly virgin forest of spruce, balsam fir, hemlock, yellow birch, maple, and beech. In 1926, under the direction of a forester, 5,000,000 board feet of timber, including both softwoods and hardwoods, was marked for cutting. This timber was so selected that its removal will not in any way impair the value of the area as a protection forest. Logging began in the fall of 1927 and will continue until the spring of 1929. The timber has been sold to a concern specializing in high grade lumber for piano sounding boards. The revenue from the sale will reimburse the city for the purchase of the land and timber.

The contract under which this timber is being cut is similar to the contracts under which the Forest Service of the United States Department of Agriculture sells national-forest stumpage. Young reproduction already on the ground, together with the seed in the duff, will insure rapid regeneration on the areas left open by the cutting of merchantable trees. To increase the percentage of spruce in the new stand all skidding and hauling roads will be planted in the spring of 1929 with spruce transplants. The 1,100 acres of immature timber will be ready for a selection cutting in about 28 or 30 years.

During 1928 a quarter of a million trees were planted on open portions of the Little Falls forest. Since 1916 there has been established on the forest a total of 845 acres of forest plantation, at an average cost of $10 per acre. The plantings made during 1927 cost only $8 per acre. The present program calls for the planting of from 150,000 to 250,000 trees each spring until the remaining 858 acres of abandoned farm land are reforested.

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The Need of Political Engineers

In a recent editorial article we said: "If engineering is the application of science to problems of economic service, then engineers should not hesitate to extend their activities into the uttermost parts of the social realm. Certainly there is as much need of scientific study of the economic effects of laws and ordinances as of the scientific study of strains and stresses. Who, we ask, is better equipped for such study of political economics than is the engineer?"

We were speaking of laws that relate to taxation for street improvements, all of which, in our opinion, are archaic and act to obstruct progress in city highways. Bottle-neck streets and bumpy pavements disgrace nearly every city, yet we go somewhat complacently, even though swearingly, along, making no effort to change the laws that place the entire burden of cost of all street improvement upon the owners of abutting property. That burden surely should be distributed, and the failure to distribute it accounts mainly for the prevalence of poor pavements and congested city thoroughfares.

City engineers encounter many another law or public practice that is detrimental to progress. For example, the net income of water departments usually becomes part of the general fund, and is often used for purposes entirely foreign to furnishing an adequate supply of pure water. There is no defense for such practice, except that "it has always been the practice." As a result of it, and because of certain laws, the taxpayers are often called upon to vote upon major improvements in, or extensions of, the waterworks. It needs no argument to prove that voters can not decide such matters intelligently. As well ask voters to diagnose the cause of a disease, or to prescribe its remedy.

Living in a democracy has served to blind most of us to the foolish practice of asking voters to solve economic problems relating to public affairs. If it be answered that the voters are not usually asked to solve such problems, but are merely asked to decide whether a given public improvement should be undertaken, our reply is: One of the most important, and often the most difficult, of economic problems is the determination of whether a proposed improvement should be undertaken at all. In his "Economic Theory of Railway Location" Wellington repeatedly emphasizes the economic importance of determining first of all whether a proposed railway will be profitable. His preface contains his justly celebrated definition of engineering, and his ridicule of the type of "engineers" that put multitudes of men to work needlessly.

Civil engineers have usually been content to let the voters or the directors of companies tell them what and where to build structures, without often attempting to express an opinion as to the economic wisdom of the project. Our contention is that this attitude toward a major economic problem is unwise, and that the public should be taught to seek the advice of engineers and to act upon that advice, not merely as to the design of a structure but as to the wisdom of building it. It will involve years of effort to bring about such a change in general practice, for there are not only public inertia and ignorance to be overcome, but many laws to be wiped off the statute books.

President Coolidge's Unwise Admonition Against Municipal "Extravagance"

Again President Coolidge inveighs against municipal extravagance, but again he fails to prove his case. It is not sufficient to contrast the decrease in federal debt and annual expense with that of cities. Nearly all the federal debt and much of the increased federal expense are the consequences of the world war. Moreover, the rise in prices and wages that were consequent upon the inflation of currency during the war, account for most of the increase in the cost of municipal government, the balance of the increase being usually accounted for by the rise in productivity of our people.

President Coolidge has been singularly efficient as a reducer of federal expenses, but he has not shown, in any of his public utterances at least, appreciation of the two economic factors just mentioned—(1) rise in prices and wages and (2) increase in per capita productivity.

This increase in productivity is what has made it possible for nearly every American family to own at least one automobile. If, then, these same people find it not only desirable but possible to own better pavements over which to drive their machines, it will be futile to read them lectures on "economy" as to that sort of purchasing—futile and positively misdirected exhortation.

A very great part of the increase in municipal expenditure has been for educational purposes. Shall this be curtailed?

Another considerable part has been for sanitation. Shall this be curtailed? Shall we spend less for sewers and sewage disposal? Shall we spend less for adequate water supply and proper "treatment" of the raw water?

Those of us who are best qualified to know, would tell President Coolidge that neither our sewers nor our

waterworks are overbuilt or overmanned. Quite the contrary. Here is Chicago, for example, that has just been ordered by the federal court to build sewage disposal plants. There is many a community that would benefit from such an order, for most of our rivers are badly and unnecessarily polluted.

When the average American is about to leave for Europe or Asia, he receives typhoid vaccination. Why? Because most of the cities of Europe and all those of Asia are without pure water. It costs money to provide adequate sanitation, but most Americans are willing to pay the bill for devices and chemicals that prevent typhoid and similar diseases.

President Coolidge looks only at the millions spent by our cities, without analyzing the nature of the expenditures, to say nothing of weighing against those expenditures the value of the services and things secured.

There are certain "economies" that are the worst of extravagances, for they result in the wastage of health and life, and the halting of industrial progress. Against the cost of progress there should always be set the profit of progress. Russian and Chinese cities are exceedingly "economic," if you measure their annual expenses in per capita outlay. Yet they illustrate the acme of municipal waste, for their saving in money is at the expense of enormous death rates and a general ignorance that is appalling.

Is Scientific Education Sufficiently Scientific?

Effective methods of solving problems and well established habits of using those methods, constitute all there is of good education.

An effective method is the mental tool, and established habit is the skill in its use resulting from practice. Few educators, we believe, will question these principles, which makes it the more surprising that so many educators fail to apply them. Tested by these principles more than half the time of students below the college grade is wasted; and a very large part of student time in college is almost thrown away.

For example, college text books on political economics fail utterly to teach methods of solving economic problems. Most of them do not even attempt to teach such methods, but merely present the results of the thinking of other men. The same applies to history, except that in the latter case usually not even the results of thinking are presented, but only series of events, supplemented perhaps by the historian's opinions about some of them. Biology, whether in the animal or in the vegetable kingdom, is still in almost as useless a stage as an instrument of education as is history. The languages are obviously not taught as tools of thinking. Even logic, which comes with the greatest of claims as a teacher of correct methods of solving problems, departs without having fulfilled a tithe of its promises.

Geology is curiously like history, even yet, little but a collection of facts, insofar as it relates to paleontology, and scarcely more with respect to the rest that it teaches. What boots it that I can tell granite from mica-schist, if I still remain incompetent to solve an original problem in petrology? What have I truly learned as to methods of attacking such problems, if all I have learned is how to distinguish one mineral or one rock from another? I am no better qualified as a thinker than is the botanist who can merely name the genus and species of a flower.

Naming and classifying are desirable parts of scientific knowledge, but after all they are merely the language of a science, and not its methods of research or of problem solving. The text books in many branches of science remain little else than scientific dictionaries.

When we pass into the realms of physics and chemistry a change appears. Here theories are in ascendence. The causes of effects are shown, and mathematical relations are often expressed in formulas. But even here something is usually lacking. Rarely are we told just how Faraday came to discover the relationship between electricity and magnetism, for example. We are merely told what the relationship is. This, however, leaves us helpless to establish similar relationships ourselves, or even to solve vastly simpler physical problems unaided.

We learn that atoms unite in definite proportions as to weight, but how many of us know even the name of the discoverer of "the atomic theory"? And if we chance to remember his name, how many of us know how Dalton came to make his epochal discovery? And if we know that, how many of us can tell just what principle of reasoning Dalton applied in that research problem? Or why he felt justified in announcing the law without waiting to test it by more than a very few facts?

Perhaps one reason why we are so seldom taught the methods used by successful researchers is because research is commonly regarded as the special empire of genius, through which the average man may wander with awe but not with personal profit. If so, just here is where our educational system is perhaps most weak. It fails to recognize that the methods used so effectively by research geniuses are the identical methods that every man must use in the successful solution of any problem.

The preliminary gathering of many data; the careful classification and analysis of the data; the memorizing of a great many facts; the forming of an hypothesis or theory that explains certain facts by showing their cause-effect relation; the testing of the hypothesis by appeal to facts not used in forming the hypothesis; the constant use of simple analogies or likenesses in framing hypotheses—these are some of the principles that successful business men, as well as successful researchers in physics, employ. But how often are these principles taught in text books? And even when partly taught, how often is the student given such prolonged coaching that he habitually applies the methods in after life?

Judging from the meager use of technical libraries by engineers, there is a woeful lack of application of the first principle above given, namely "the preliminary gathering of many data."

W. P. Gillette

Municipal News and Water Works

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Construction Features of Granville Dam for City of Westfield, Mass.

How a $630,000 Earth Dam Project Is Being Handled

By E. B. MYOTT

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THE construction of this project, now under way, involves a total expenditure, exclusive of the purchase of land, of $630,000. The work comprises the building of an earth dam and appurtenant structures, the preparation of the reservoir site for the storage of water, and the building of a short supply main. Most of the work is being done under contract.

Bids for the work were received Sept. 12, and the contract was awarded to the low bidder Oct. 28, 1927. Fifteen contractors submitted bids, ranging from $430,000 to $880,000; the lowest bid was 26 per cent below the average of all bids.

Construction work began in the late fall of 1927 and continued to February, 1928. Only a very small amount of work was done during this period; namely, the construction of a contractors' camp, the laying of about 600 lin. ft. of 20-in. pipe, and the erection of a cableway. Work began in earnest in April, 1928, and was carried on as fast as practicable until the first of December, 1928, when all operations were stopped on account of weather. During this period, work costing $350,000 was completed. The indications are that the project will be completed well within the specified time of Oct. 31, 1929.

Order of Operations.—The order of operations decided upon at the beginning of the work required the completion of all concrete work and a small amount of the embankment during 1928. Although it was necessary to do much more rock excavation and concrete work than was originally planned, due to the character of the foundation material, all of the concrete work was practically completed and also about one-quarter of the embankment.

Work was first started, at the dam, on the outlet conduit. The construction of the cut-off wall, the preparation of the dam site for the embankment and the construction of the upper gate house then followed and this work was carried on simultaneously. During the latter part of the season, the excavation of the road on the south bank of the dam, the construction of the spillway and spillway channel and the lower gate house was nearly completed; the borrow pit was opened and the earth embankment completed to an average height of 16 ft.; a considerable amount of

The Stone Toe

work was done in preparing the reservoir site for the storage of water; and the 20-in. supply main was completed.

Outlet Conduit.—The outlet conduit consists of a reinforced concrete pipe 42 in. in diameter, and a 24-in. cast iron pipe embedded in concrete, about 740 ft. long, built in a rock trench varying in depth from 3 ft. (outside the dam) to 25 ft., and averaging about 15 ft. The flow of the brooks is diverted into the conduit through a special inlet structure. It is discharged into the old brook channel a considerable distance below the dam. The conduit passes through the upper gate house, where gates will control the flow of water in it.

The construction required especial attention, as it was necessary to establish the profile as the trench excavation progressed. The rock encountered for the entire length of the conduit was granitish gneiss, traversed by many seams in a very irregular manner, and in many places badly disintegrated. This not only made the excavation much more costly to the contractor, as a large amount of rock was excavated without blasting, but it was necessary to remove much more rock and use much more concrete than originally anticipated. Only light charges for blasting were permitted by the specifications, and this specification was strictly enforced. The depth of all holes only average 2.6 ft. and the amount of dynamite used was kept to a minimum.

The conduit was built in sections averaging 40 ft. in length. Concrete was first poured to the spring lines of the 42-in. The second pour was to a height of 9 in. above the crown. The cast iron pipe was then laid and the concrete poured around it.

Wooden forms were used for the 42-in. conduit. They were built semi-circular, in sections 10 ft. long, of 2-in. by 8-in. ribs spaced 2 ft. on centers, lagged with ⅞-in. by 1⅞-in. stock.

Concrete collars were built about every 30 ft. at the bottom and sides of the trench and to the top of the banks of the trench, to prevent any seepage along the conduit.

A 400-ft. cableway was used for removing the excavated material, handling the cast iron pipe and other material over that part of the trench where the excavation was the deepest. A Byers crane was used for this purpose on the remainder of the trench. Most of the concrete was poured from portable mixers located along the bank.

This structure was completed in four months at an average cost of $67 per linear foot.

Cut-Off Wall.—It was thought, previous to construction, that only a simple cut-off wall would be required. The contract drawings called for a concrete wall to be built across the floor of the valley in as narrow a trench as possible, resting on bed rock and extending above the surface of the ground about 5 ft. As bed rock is very deep on the banks of the valley, it was planned to use timber sheet piling together with a simple wall there, or an earth cut-off. Timber piling could not be driven and it was decided to build the cut-off of concrete for the entire length of the dam.

Excavation for cut-off wall was first started on the south side of the floor of the valley. As soon as bed rock was encountered, it was tested for watertightness. One-inch holes 10 ft. deep took water at the rate of about 5 gal. per minute under a 20-ft. head at the bottom of the hole. This fact, together with knowledge obtained regarding the character of the rock from the outlet conduit excavation, caused a change in the design of the wall.

The material overlying bed rock, across the floor of the valley, is silt, sand, gravel and large boulders and is very compact; on the north bank there is a layer of hardpan overlying soft, reddish, fairly uniform sand; on the south bank, the material is silt, grey granitish sand and fine gravel; and at the southerly end of the dam, there is a considerable amount of rock flour silt.

The trench across the floor of the valley was opened to an average width of 8 ft. at the bottom and 20 ft. at the top, but on the banks of the valley, the trench was kept to a minimum width of about 3 ft. A seal coat of concrete was poured over the bed rock and the bed rock was grouted. The wall across the floor of the valley was built on the downstream side of the trench. It was built in sections 40 ft. long and that

Cut-Off Wall on South Bank of Valley

part below ground surface was built in steps. Walls were built across the trench at the end of each section, enabling the puddle backfill, which consisted of rock flour silt and topsoil, to be placed in sections. The wall across the valley was built to an average height of 10 ft. above the ground. Particular care was taken in grouting the foundation and building the wall at its intersection with the outlet conduit. On the banks of the valley, the depth of the trench varied from 12 ft. at the foot of the bank to 9 ft. at the top and the height of the wall above the ground surface varied from 10 ft. at the foot of the bank to 5 ft. at the top. Passageways were left in the wall for use later in hauling the material to the dam for the embankment.

Grouting Bed Rock.—The entire length of bed rock was grouted. A set of 1-in. drill steel was used which gave a diameter of hole at the top of about 3 in. The holes were spaced 15 ft. center to center in two lines about 7½ ft. apart and the locations of the holes were staggered. A total of 60 holes were drilled, 52 of which accepted grout. At the beginning of the operation, the grout was mixed in the proportion of 1 part cement and 7 parts water. As the hole tightened, the mix was increased to 1 part cement and 3 parts water. The grout was first applied under a pressure of 15 lb. and gradually increased to 80 lb. The minimum amount of cement used per hole was ½ bag, the maximum 75 bags and the average 10¼ bags. A very small amount of grout was lost. The total cost of grouting was $2,475 or about $4.25 per linear foot of hole.

At the present time, the cut-off wall is practically completed. Four months were required to build the wall and the average cost per linear foot was $92.

Upper Gate House.—The upper gate house is a reinforced concrete structure 22 ft. by 30 ft. and approximately 85 ft. high with a 1-story brick superstructure. It consists of a drywell and a wetwell. The wetwell does not extend to the very bottom of the structure, there being a large section of mass concrete about 28 ft. high underneath it. The reinforced walls for a height of 28 ft. above the foundation are 4 ft. thick; and above this they are 3 ft. thick.

Lower End of Spillway Channel

This structure was built on a rock foundation of the same character of rock as was encountered in the outlet conduit trench. It was necessary to excavate more rock and to place more concrete than was originally estimated. The concrete in this building was placed in pours as large as practical, averaging about 100 cu. yd. per pour. The concrete for the lower part of the structure was poured by gravity from a mixer located on the south bank; that in the middle part of the structure was handled from the mixer by a crane. A steam hoist elevator was used to handle the concrete above this elevation. The forms consisted of 2-in. by 6-in. spruce planed on one side with 3-in. by 4-in. studs 2 ft. 0 in. center to center and 4-in. by 6-in. ribbons 3 ft. 0 in. center to center. The forms were double wired 3 ft. 0 in. center to center both ways.

The progress of the work depended upon the construction of the forms and as only a limited number of men were able to work on the forms at one time, the construction of the building progressed slowly.

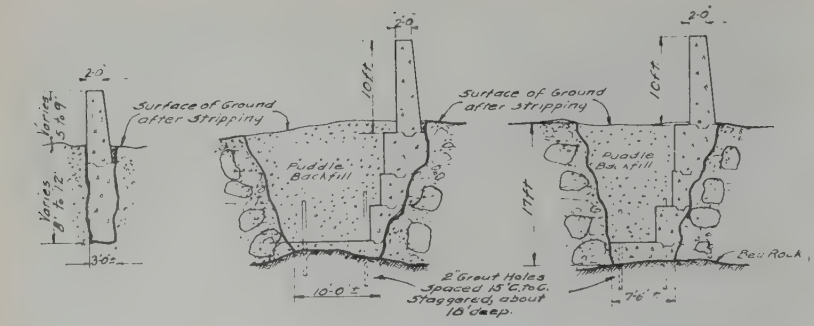
The total cost of this structure will average about 95 ct. per cubic feet of gross volume.

Rolling Earth Embankment

Main Dam.—The dam is an earth embankment built by the layer fill method, with a stone toe and heel, and stone facing on the upstream slope. 240,000 cu. yd. of earth, 30,000 cu. yd. of stone, 8,000 cu. yd. of gravel and 2,000 cu. yd. of soil dressing will be used. The stone embankments and facing have been laid out to utilize all of the stone excavated for appurtenant structures and all stone encountered in the borrow pit. The average cost per cubic yard of the entire embankment will be about 85 ct.

Preparation of the Site.—The first work in the construction of the main dam was the preparation of the site for the embankment. This work included the removal from the site of all stumps, topsoil, loose boulders, and material which in its natural state was quite permeable.

A large part of this work was done by a steam shovel. The final operation


Surface of Ground after Stripping
Puddle Backfill
2' Grout Holes Spaced 15' C. to C. Staggered, about 18' Deep.
Surface of Ground after Stripping
Puddle Backfill
Bed Rock
On Banks of Valley
Across Floor of Valley
Scale 1"=10'

Typical Cross Section of Cut-Off Wall

of cleaning up the loose material left by the shovel was done by hand labor. This work progressed slowly at first due to the difficulty of hauling the material away. The Linn tractor was of particular value, having no difficulty in hauling a full load over rough ground on a grade of 20 per cent.

Many boulders were encountered in the stripping of the site. It was necessary on account of these boulders to do a large amount of the work by hand labor. All loose boulders were removed for use in building the stone toe of the dam.

Work at the Borrow Pit.—While the work in preparing the dam site was under way, a road was excavated to the borrow pit and a part of the pit was grubbed and stripped.

The pit is located on the north bank of the valley about ¼ mile from the center of the dam. It is on a side hill with an average cross slope of about 3 to 1.

Investigations conducted previous to construction and since proved to be correct, showed that this side hill was covered by a layer of hardpan approximately 10 to 15 ft. thick at its junction with the floor of the valley and 60 to 80 ft. deep at the top of the hill. Underlying the hardpan, there is a large volume of uniform reddish, micaceous sand which is very permeable, and therefore unsuitable for the earth embankment.

The contract permitted the contractor to open the borrow pit in any location he deemed desirable on the side hill, but not nearer than about 300 ft. from the embankment. He elected to open the pit at about elevation 550, about 10 ft. above the top of the dam, where the depth of the overlying hardpan would be great enough to permit the economical excavation and handling of the material. The road from the pit to the floor of the valley at the dam site is on an average grade of 10 per cent. As the height of the embankment increases, the alignment of the road will be changed somewhat, thus decreasing the grade of the road.

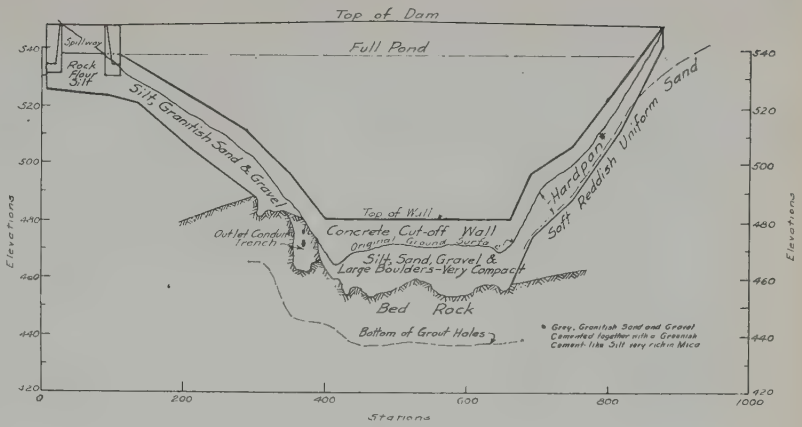
The excavation in the pit is being carried to the entire depth of the good material. It is being made by two Byers steam shovels, equipped with ¾-yd. buckets. These shovels are capable of excavating the bank to a height of about 25 ft. It was first planned to terrace the cuts with depths not greater than could be made by the shovels in one cut, but this idea has been abandoned due to the difficulty of handling the hauling equipment in the pit. When the height of the bank reaches about 25 ft., a cast over cut is made from the

Cut-Off Wall at Intersection with Outlet Conduit

top of the bank by a Byers gasoline shovel equipped with a 1-yd. bucket. This shovel casts the material over the bank, where it is rehandled by the steam shovels before another cut into the bank is made. It is not necessary to use the gasoline shovel on this work all of the time.

The hardpan is very difficult to excavate. The teeth of the buckets are made of manganese steel, but it is necessary to change them frequently. The excavation of this hardpan could be done more economically by larger and more powerful shovels, but, however, the size of the shovels being used fits in very well with the general scheme of handling the material. They are quite speedy and are capable of excavating the material as fast as it can be properly handled at the embankment. If larger shovels were used, additional spreading, rolling and hauling equipment would be required.

Hauling of Material from the Borrow Pit to the Embankment.—At the beginning of the work, the contractor was undecided on the type of equipment to use for hauling the material from the pit to the dam. Numerous types were considered; namely, belt conveyors and trucks, auto trucks, Linn tractors, and tractor trains. The contractor purchased a 7-ton Linn tractor for general use on the job, and as soon as the earth embankment was started, this machine started hauling from the pit.



Profile of Cut-Off Wall

A 60-hp. Caterpillar tractor, manufactured by the Caterpillar Tractor Co., and two bottom dump steel wagons, manufactured by the LaPlant-Choate Manufacturing Co., were purchased on trial. Three-ton Mack trucks equipped with dual-pneumatic tires on the rear wheels were hired. Time studies were made to determine the comparative cost of hauling the material by the machines. These studies were made at the beginning of the work when hauling conditions at the embankment were poor and at a time when the pit was not large enough to permit the easy handling of the equipment there. As a result of this study, additional tractors and wagons were ordered at once. As the hauling conditions at the embankment and in the borrow pit improved, it was found that the Caterpillar tractors could haul three wagons and the Linn tractor could haul in addition to its usual load, one wagon, and therefore, additional wagons were ordered. At the end of the season, the material was being hauled by three tractor trains of three wagons and by the Linn tractor and one wagon. It is expected that the remainder of the filling material will be hauled by this equipment only.

Work on the Embankment. — The work at the embankment consists of

Work at Borrow Pit

spreading and rolling of the material; the sorting from the earth of roots over ½ in. in diameter and stones over 6 in. in the greatest dimension. A 60 hp. Caterpillar tractor equipped with a LaPlant-Choate bulldozer is used for spreading the material. A 7-ton Buffalo-Springfield roller is used to assist the other equipment in compacting. A 1½-ton truck, a foreman and five men are used to sort the roots and stones, direct the dumping of the earth and the placing of the stone and gravel.

Amount of Compacting.—Perhaps the most essential factor to consider in building earth embankments is the compactness of the mass, as the greater the compactness the greater the weight, and in most cases the greater the imperviousness.

The specifications for this job require "the filling material shall be distributed in approximately horizontal layers not exceeding 6 in. in thickness when compacted. . . . The compacting shall be done by approved rollers having grooved or banded rolls and operated by mechanical power except that in small embankments and around the structures other means approved by the engineer may be used. The heaviest wheels of the roller shall cause an average pressure of at least 250 lb. per linear inch width of roll. The roller shall pass over every portion of each layer as many times as may be necessary, but not less than six times in any case."

This specification conforms closely with the specification commonly used for the building of layer filled embankments. The specification commonly used does not include an allowance for compacting done by equipment other than that used for rolling alone. Before motorized equipment became so common in use, the compacting of embankments was done by horse drawn rollers and by the trampling of stock. In the early dams, the material was hauled to the embankment in most cases by horses and wagons, and later by industrial trains. At the present time, with the heavy motorized equipment available, such as we are using in Westfield, consideration must be given to the amount of compacting which it does. It is true that this type of compacting is not entirely uniform, but it can be quite carefully controlled.

The engineers on this project were very much pleased when the contractor decided to use tractors and the large wagons. Surely the compacting resulting from a 10-ton tractor working on the embankment is very beneficial.

The distance travelled and the area covered on the embankment during a 9-hour day, while building a layer 5½ in. thick after being compacted, together with the wheel loads of all equipment have been determined. With these data and knowing the area of the embankment, the average number of trips made on the embankment per layer is computed for each machine. The product of the average number of trips and the average wheel load per linear inch width of tread gives the relative amount of compacting.

The relative amount of compacting given for the tractor treads should possibly be reduced to conform more closely with the amount of compacting given for wheel loads, due to the additional concentration of a wheel load. However, considering wheel loads only, the amount of compacting done by the wagons alone exceeds the minimum requirement of the specifications.

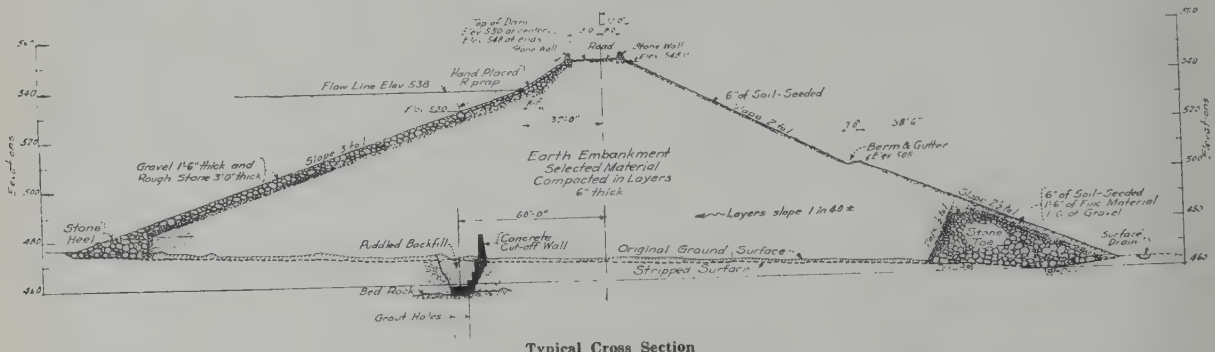
Specifications for layer filled embankments should be written to conform with the equipment to be used and the specifications should be complete and include an allowance for the compacting done by the hauling equipment. On this particular job, much more compacting is being done than was specified, but if the contractor had decided to haul the material to the dam by industrial trains or by other means, which would not give the amount of compacting equal to that represented in the tabulation, additional rolling equipment would have been required.

Numerous test pits have been dug in the embankment. Below a depth of 1 ft., it is impossible for a laborer to dig the material without the use of a pick. Laborers say that it is as difficult to dig as any natural material they have ever dug. Unfortunately, we have not at the present time, any figures which we can safely rely upon to give the amount of shrinkage of this material. At the end of this work, we will have quite definite figures for this factor.

Soil Tests.—The various kinds of soil encountered are tested in the field office by a simple method worked out by Dr. Charles Terzaghi of the Massachusetts Institute of Technology. The method involves the use of a device for measuring the capillary rise of water in soil.

Last season, 425 samples of material were tested in our field office. Of this number, 264 were of material being used in the dam embankment. The average coefficient of permeability of the 264 samples is .00007 cm. per second and the volume of voids 34 per cent. The line of saturation and the amount of leakage expected were computed on the basis of the coefficient of permeability averaging .0001 cm. per second. The material is some better than originally anticipated.

A system of pipe drains has been built underneath the stone toe, the main drain of which passes through a catchbasin just below the dam. Ditches which will collect the surface drainage on the face of the dam will discharge into this catchbasin. A weir has been built in the catchbasin so that the amount of leakage through the dam can be measured. Weirs have also been built on each brook at the head of the reservoir. During the construction period, daily records are kept of the flow of water over these weirs and also the flow of water in the brooks after they join at the mouth of the outlet conduit. If records are kept of the amount of water used from the reservoir after construction and the amount of water entering the reservoir, together with the heights of the reservoir, and the amount wasted, the approximate amount of leakage through the walls of the reservoir may be determined. Such a figure will be of particular value to check the estimates made of the leakage by the geologists.



Typical Cross Section

Miscellaneous Structures.—The lower gate house, a small structure 16 ft. by 20 ft., consisting of a concrete basement and brick superstructure, houses gates which will control the flow of water in the supply main. Provisions have been made in the layout of the piping so that the water may be returned to the brook or to an aeration plant, which may possibly be needed.

The supply main extends from the lower gate house along the brook a distance of ½ mile to a connection with an existing main. It is a 20-in. c. i. pipe laid in a trench with an average depth of 7½ ft., located on a steep side hill. The total cost of this pipe line per linear foot was about $11.50.

The spillway and spillway channel were built on the steep south bank of the valley. At the upper end, a large amount of rock flour silt was encountered and the sides of the spillway are gravity retaining walls. Sand, gravel and rock were encountered most of the distance and the slopes of the channel are paved. Rock was encountered at the lower end of the spillway where the alignment is on a curve. The channel was built in sections 30 ft. long and on chords around the curves. Movable forms were used for the slope paving. At the lower end of the channel, difficulty was had in hauling the excavated material from and hauling the construction material to the channel, as the grade here is 18 per cent. The only hauling vehicle which could operate on this grade was the Linn tractor.

A road has been excavated from an existing road to the south end of the bridge. This road will cross the spillway and the dam. A pony truss bridge with a concrete deck has been built across the spillway. The steel for the bridge was fabricated in Worcester and the trusses, 60 ft. in length, were transported via highways to the site. Only a small amount of trouble was had navigating the truck and trailer around the sharp curves approaching the job.

A considerable amount of material excavated from the road and spillway channel was not suitable for use in the embankment. This material was used for blanketing swampy places in the reservoir. In connection with the preparation of the reservoir site for the storage of water, some work has also been done stripping the flow line. Most of the material on the banks of the reservoir is sand and gravel. A Byers gasoline shovel has been used in making a single cast over cut along the flow line. This results in thorough stripping for a depth below the flow line of about 10 ft. and blanketing a similar depth below the cut. This scheme of treating the flow line eliminates a great amount of hauling of the stripping material and leaves the shores of the reservoir in a much better appearance.

General.—The contractor, the C. & R. Construction Co. of Boston, has cooperated fully at all times with the engineers on this project. The job has been exceptionally well equipped at all stages of the work. The total cost of all equipment used amounts to $124,000.

Previous to beginning the construction work which has been described, the city did a considerable amount of work in preparing for a reservoir in this location. 300,000 pine trees were planted on the watershed as a part of the reforestation work so well done in this city. Nearly all of the land in the watershed has been acquired, and all possible sources of pollution have been eliminated.

Acknowledgment.—The foregoing is an abstract of a paper presented Feb. 13 before the New England Water Works Association.

Treatment of Paper Mill Wastes

The recently issued 1928 report of Abel Wolman, Chief Engineer Bureau of Sanitary Engineering, Maryland State Department of Health, contains the following:

The investigation at the paper mill of the Congoleum-Nairn, Inc., which has been in progress for several years, was continued. Experiments were conducted on the waste treatment plant, which was placed in operation in 1927, to determine whether some other coagulant than alum might be used. During the course of the experiments, ferric chloride alone, ferric chloride plus lime, alum alone and alum plus sulphuric acid were used. The results obtained with ferric chloride were not sufficiently better than with alum to justify a change. A treatment of 90 grains per gal. of lime and 50 grains per gal. of alum produced an effluent approximately equal to that obtained with alum at the rate of 140 to 180 grains per gal. Further work along this line will be done to reduce the amount of waste still reaching the stream.

In the operation of the coagulating basins a new procedure has been used. The basins were so designed as to make it impossible to draw off all of the supernatant liquid from the tank, the outlets being 2 ft. from the bottom of each basin. Formerly, this entire 2-ft. depth was discharged to the lagoon. It is now taken from each tank to one coagulating basin where it is re-treated and re-settled. The supernatant from this tank is discharged to the stream and the resulting sludge discharged to the lagoon. The supernatant liquid from the lagoon is run off to a cinder bed and thence to a second cinder bed from which it passes to the stream. These cinder beds are 4 by 6 ft. in area and contain 5 in. of cinders and 5 in. of sand. The cinders and sand are removed and replaced with new material about every fourth day. Treatment of the cinder bed effluent with lime would produce an excellent floc and a practically water white supernatant, but this treatment has not been required since the amount of discharged waste has been very small.

Court Decision on Construction of Sewer System

Public Health Reports for Feb. 15, gives the following court decision handed down Nov. 23, 1928, by the Kentucky Court of Appeals in the case of Baker v. City of Princeton (11 S. W. (2d) 94):

Chapter 88, Laws of 1928, authorized the construction, maintenance, etc., of sewers in fourth-class cities. After this statute went into effect, the city of Princeton, a fourth-class city, passed an ordinance providing for the construction of a sewerage system.

About 20 years before, the city had constructed a small sewer system in the business section, which system served a few residences, including two belonging to the plaintiff. A fee of $20 was paid to the city for the privilege of connecting with the system, and there was no further charge.

The plaintiff instituted an action to enjoin the city from proceeding with the letting of contracts and the construction of the sewer system under the above-mentioned law and ordinance. It was insisted that the plaintiff and others who had paid the fee of $20 had acquired a vested right which the city could not interfere with or take away. The court of appeals did not take this view of the matter, saying that "The mere right to tap a sewer system in consideration of a specified fee is simply a temporary privilege which must yield when it becomes necessary to discontinue the old system, and construct a new system in order to promote the public health."

One of the other points made was that the city council was without power to create a single district but should have created several districts so that the burden would fall more equally on the property owners. Concerning this the court said that "There is nothing in the act that requires a city council to divide the city into separate districts. On the contrary, the whole matter is left to the sound discretion of the board of council (cases cited), and the courts are without authority to interfere, even though they may believe it would be more advisable to adopt a different plan."

The court concluded its opinion by saying that "the city has the power to construct the proposed sewer system in accordance with the terms and conditions contained in the ordinance."

City-County Consolidation in California

The San Francisco Bureau of Governmental Research in a recent report recommends the consolidation of the city and county of San Francisco with San Mateo County into one unit as a "city-county with adequate provisions for local representation on a central legislative body, a centralized administration of common governmental functions, and the retention of local powers and control of local functions by local units, or boroughs." The proposal has a double purpose, as do most of the proposals for metropolitan government, namely: (1) to provide adequate services for a growing metropolitan district in the way of highways, regional planning, water supply, sewage disposal, port facilities, transportation, schools; (2) to eliminate duplication of functions in, and reform faults of existing units of government. The proposed new unit would include a population of 745,000 and an area of 489 square miles.

Weighing the Probable Truth of a Theory

By HALBERT P. GILLETTE, Editor

THERE is a prevalent belief that men equally informed as to the facts are equally competent to weigh the merits of a scientific theory; but the history of science shows that a very large percentage—usually a great majority—of scientists have not been competent to appraise a new theory.

Newton's theory of gravitation was not generally accepted in Europe until long after his death. Prout's theory of the genesis of atoms from hydrogen was rejected by all authorities for nearly a century. Einstein's theory of relativity was practically ignored by scientists for 15 years after its publication. Each of these three theories was supported by quantitative evidence that should have carried conviction the instant the theory and the evidence were grasped. These three are typical of scores of quantitative theories that have had to wait decades, or even generations, before general acceptance was secured.

After making allowances for mental inertia, skepticism, egotism and all the psychological conditions that prevent an impartial and thorough study of a new theory, a good deal of mystery remains as to the slowness with which a true theory receives general approval. It will not do to attribute such slowness to commendable scientific caution, especially where the evidence was overwhelming when the theory was first announced. We must look for other reasons.

In searching for other reasons I have come upon one that seems to explain most of this phenomenon of skepticism about new theories. It is the prevalent failure to test new theories by the laws of probability. Treatises on logic usually discuss such tests in the most perfunctory manner, if they discuss them at all. Treatises on probability are often but little better, for their authors usually seem to have scant appreciation of the power of the science of probabilities in testing theories, to say nothing of its usefulness in discovering natural laws.

Of the 90 known atoms (out of the 92 that are supposed to exist) about one-quarter have atomic weights that are integral numbers. When, in 1815, Prout announced his theory that hydrogen atoms are the "bricks" of which the other atoms are built, the percentage of the then known atoms that possessed weights that were integral multiples of that of hydrogen exceeded 25 per cent. Let us assume, however, that 10 atoms in 40 exactly corresponded with Prout's theory. What was the probability of its truth? If any atom selected at random had an atomic weight that was an integral multiple of that of hydrogen, the probability that it would have such a weight merely by chance would be excessively small. But let us assume that it would be 1 in 2; or that it either would or would not have an integral weight. Then if 10 random selections from the 40 resulted in finding 10 atoms having integral weights, the probability of this happening purely by chance would be only 1 in 2 to the 10th power, or 1 in 1,004. Since there were 40 atoms, the fact that only 10 of the 40 had integral weights, would reduce the probability to 1 in 251. Even 251 to 1 in favor of a theory is overwhelming evidence; but remember that in this case we have assumed an initial probability of 1 in 2, which is far too small a ratio. All the possible weights that an atom might have other than an integral multiple of hydrogen, are so nearly infinite that we have no means of estimating them. When, therefore, we say that the chance is even that an atomic weight will be an integral multiple of hydrogen, we are grossly over-estimating that chance. Indeed so gross is our over-estimate that we are safe in saying that if even 2 atoms out of 90 have weights that are integral multiples of one another, they are almost certainly related as causes of one another, or a concomitant resultants of a common cause.

But the chemists looked only at the instances where Prout's theory seemed to fail, and never weighed the significance of the instances where it held true; so they rejected the theory for a century. Recently it has been found that where atoms have fractional weights, they are mixtures of isotropes that have integral weights. Thus chlorine has an atomic weight of 35.46 as a result of the mixture of three isotropes of chlorine whose weights are 35, 37 and 39. So the very exceptions that were cited against Prout now are seen to prove his rule.

Were this an isolated instance of the misjudging of a scientific theory by all the authorities save its originator, it should at least serve as a warning to skeptics. But it is not isolated. On the contrary, scientific history swarms with similar instances. Of course the initial evidence in favor of many a new theory is relatively weak, but actually the degree of its weakness is rarely demonstrated by an appeal to the law of probabilities. Instead, the critics merely guess that it is weak; and usually their guesses are influenced by its apparent failure to agree with some known fact or facts, rather than by its proved agreement with several known facts.

When any theory is in close quantitative accordance with even a very few facts, it is rare that it fails to show a very high degree of probability if tested by the laws of probability.

One celebrated astronomer, commenting on the slowness with which Newton's law of gravitation was accepted, says that this slowness was not surprising because Newton had not shown its accordance with very many astronomical facts. This statement is clear evidence of this astronomer's ignorance of the use of the laws of probability in testing such a theory; for, had Newton only proved that his law held true of the earth and the moon, still that proof would be very convincing to anyone familiar with the elementary principles of probabilities. But Newton's law fitted Kepler's laws so perfectly that he had thus extended it to include all the known planets; and he had also carried it far enough to explain quantitatively the height of the ocean tides. Truly it is astounding to find any astronomer hesitating to accept such proof as conclusive.

If it be argued that Newton wrote when science was in its infancy, the answer is Einstein's experience. Einstein offered in proof of his relativity theory that, by its aid, he had deduced two laws previously deduced by Lorentz, who in his deduction, had used the well established principles of electrodynamics. That alone was proof overwhelming that Einstein's relativity theory must be sound. But Einstein added one of the most spectacular tests of a theory that has ever been published. He deduced, by his theory, the 43 secs. of arc per century through which Mercury's orbital axis rotates, in excess of the rotation accounted for by Newton's laws; and his deduction agreed with the fact within the observational error. Yet this marvelous proof of his theory caused scarcely a ripple of interest in a scientific world which, 25 years later, is all agog over Einstein's latest development of the same theory. It is true that one of Einstein's original predictions was found to be correct 10 years ago, and that this awakened the attention of the scientific world. But this itself shows a surprising ignorance of what constitutes a crucial test of a theory. To predict a future occurrence accurately is certainly spectacular, but it is not a whit more difficult than to deduce from a theory a quantitative result in accordance with any known fact that was not used in deriving the theory. Einstein's deduction of Mercury's known orbital change was just as conclusive evidence of the truth of his theory as was his deduction of the amount by which a ray of light bends when it passes near the sun. That thousands of modern scientists failed to appreciate that this is so, is one of the most conclusive proofs that few of them know how to weigh evidence scientifically.

There is great need, therefore, of study of the principles of probability, and particularly of their application to measuring the worth of new theories. In a later article I will indicate the use of the science of probability in discovering natural laws.

Westchester County Planning and Park System

Some Interesting Facts on a Notable Park Development

ONE of the most notable park systems in this country is that of Westchester County, New York. An interesting account of the development and success of this work was given by Jay Downer, chief engineer of the County Park Commission in a paper presented at the 1929 annual meeting of the American Society of Civil Engineers. The following digest of Mr. Downer's paper is taken from the March Proceedings of the Society.

Outstanding Accomplishment.—"Westchester County, New York, during the past five years has made a contribution to park history, regional planning, and practical execution hitherto unmatched by any other municipality in the world in an equal period of time. Three outstanding features may be offered in support of this rather broad claim: First, the comprehensiveness of the County Park System which includes water-front and interior recreational areas and reservations, and an extensive system of interconnected traffic parkways; second, the speed of execution in the acquisition of lands, development, and construction work; and, finally, the self-supporting financial basis attained through the creation of property values and the development of revenues from special park privileges and facilities."

The County and Its Problem.—Lying just north of New York City, the County has 448 sq. miles stretching between the Hudson River and Long Island Sound. It embraces forty-five subordinate municipalities, including four cities, and boasts a total population of 500,000. Coincident with New York City's northward growth, development in Westchester County has been startling, being especially accelerated during recent years, and now along its Southern border being almost a continuation of New York City. Being of ancient origin, the various towns are connected with an extensive network of highways, many of them dating from the Colonial period—a typical rural road system. It was with such a problem that the County Park Commission had to cope.

"Scenic attractiveness," said Mr. Downer, "accessibility to New York City, and the trend of present growth strongly indicate Westchester County's future destiny as the most attractive residential area of the New York Metropolitan District. Industrial development in this area is very limited and, aside from control through zoning ordinances, the physical characteristics of hill and valley topography make Westchester less attractive for industrial invasion than the flat expanses of Jersey meadows threaded by water and rail transportation facilities.

"Broadly stated, the planning problem presented by Westchester County is that of a large satelloid area directly in the only mainland path of growth of New York City and destined to be devoted to residential purposes as its major utilization, but with local distribution and retail business districts to supply the needs of a greatly increased future population. Among the leading essentials for the planning of this area are the requirement of maintaining and enhancing the natural endowment of attractiveness for residential uses and the necessity for providing open traffic ways for the large volume of through-motor traffic between New York City and Upper New York State and New England which must necessarily pass through Westchester County."

County Park System.—By combining county parks for arterial traffic parkways, the Commission has been enabled to form the main elements of a general plan which is expected to mould the future development of the County very largely. Naturally, the general plan had to be accommodated to existing development and thus compromises from the ideal had to be effected. Certain well-defined fundamentals dictated this development, according to Mr. Downer. Among these he included the following:

"Elemental Features: Water-front parks along the Hudson River and Long Island Sound shores, and interior parks, reservations, and forest preserves providing for a wide range of recreational uses. An interconnecting system of traffic parkways.

"Economic Utilization of Land: Selection of the cheapest undeveloped lands, such as marshes, stream, and pond margins, or rocky uplands, undesirable and difficult to develop for residential or business uses, but ideal for park purposes and as such allocated to their most valuable economic utilization in the general scheme of county development.

"Adaptation to Physical Characteristics of Region: The diversified irregular and somewhat bold topography precluded conventional geometric planning. Such planning could not be rationally or economically adjusted to the physical conditions.

"Adjustment to Existing City, Town, and Village Developments: Interwoven with the foregoing was the necessity for effecting the most feasible compromises with existing conditions of the unplanned suburban growth.

"Rapidity of Execution: One of the most important elements was prompt action in acquiring lands in advance of rapidly rising values, leaving the shortest possible gap between planning and the execution of this phase of the program."

Parkways.—After showing the general layout of these parks and parkways, Mr. Downer continued:

"The north and south parkways, traversing the stream valleys in the direction of greatest traffic flow, serve the multiple purposes of open recreational areas, motor traffic routes of least resistance, the natural drainage routes of trunk sewers, and possible future locations of water supply conduits and other public utilities. The parkway reservations which include controlling strips of land on both sides of the streams also forestall the development of nuisance conditions such as developed along the Bronx River Parkway and led to its construction principally as a sanitary improvement project prior to the general county park program. The parkway system is coordinated with the older existing county highways."

The first of these parkways, Mr. Downer explained, called the Bronx River Parkway, was a joint undertaking between Westchester County and the City of New York. It extends 12 miles through the county and 3 miles within the city. About three years before this work was finished, the County adopted its expanded park program, working under a park commission of six members serving without compensation. One year was devoted to study, after which definite recommendations were made, all of which were adopted by the County Board of Supervisors and the requisite appropriations unanimously voted.

Extent of Park Development.—As a result of five years' active work, said Mr. Downer,

"The Commission has established a regional park system embracing within the limits of Westchester County, 16,671 acres of land, 140 miles of parkway routes, and 9 miles of beaches and shore lines along the Hudson River and Long Island Sound. This work has involved the acquisition of about 3,500 separate parcels of land, a large proportion of which was acquired by direct purchase from owners, thus avoiding the delays incidental to tedious condemnation proceedings.

"Coincidentally with the acquisition of land, a construction and development program has carried to completion seven new large-scale recreational developments, including bathing beaches, bath houses, concrete swimming pools,

a wide range of athletic, recreation, and picnicking grounds, three public golf courses, forest preserve areas, and a seaside amusement park embodying a unique and unusual feature under municipal operation. Under this development program 17 miles of fully developed traffic parkways have been completed giving a total of 29 miles, including the Bronx River Parkway."

Basic Practice in Parkway Design.—What Mr. Downer styled the "Westchester County type of parkway" is being recognized as the most economic solution. By establishing attractive residential zones along the roadways, valuations are greatly enhanced; this is largely in contrast with the depression of land values along trunk highways flanked by billboards. The Westchester practice is to utilize the minimum width of 200 ft., enlarging this where cheap land is available or where water-surface development is feasible. Mr. Downer continued:

"As to the motor driveways, the standard practice is to lay pavements 40 ft. wide for four lines of traffic. Grade separations have been effected at all main intersecting thoroughfares which are carried over or under the parkway drive by bridges. The rigid-frame type of stone-faced reinforced concrete bridge has been applied to the grade-separation problems with very satisfactory results both as to economy of construction and pleasing architectural adaptations. On the Bronx River Parkway the type of pavement was a concrete base with 2½-in. bituminous wearing surface, but the newer projects are standardized on reinforced concrete pavement, with asphaltic emulsion applied to eliminate glare. Grading and bridge openings are being carried through to a width of 60 ft., as the necessity for increasing the initial 40-ft. pavement width to 60 ft. in the not distant future is foreseen.

"Economics.—The park program is financed as to capital investment in lands and permanent improvements, through the standard type of county bonds running for 45 to 50 years and usually underwritten at an interest rate of 4 per cent. The yearly operation and maintenance charges are carried as an item of the general county budget raised by current tax revenue.

"From 1922 to the end of 1928, the total capital appropriations were as follows:

Acquisition of lands	$32,297,000
Improvement and construction	18,515,900
Total	$50,812,900

"Although not susceptible of exact calculation, it may reasonably be held that the creation of enhanced property valuations has fully offset the capital appropriations, regardless of the public welfare benefits of the park system. The sharp upward trend in assessed valuations immedately after the establishment of the park system is shown by the following figures:

Year	Total Assessed Valuation of Taxable Property	Increase
1921	$ 676,103,963	
1922	733,007,069	$ 56,903,106
1923	788,029,096	55,022,027
1924	891,331,983	103,302,887
1925	987,068,857	95,736,874
1926	1,143,871,106	156,802,249
1927	1,318,826,453	174,955,347
1928	1,501,531,153	182,704,700

"The influence of the park program is apparent in the increased valuations in 1924 and subsequent years. From 1924, when this influence became evident, up to and including 1928, the total increase in assessed valuations was $710,797,357. At the previous rate of increase the total for the same 5-year period would have been about $300,000,000. An increase of about $410,000,000, or about eight times the total amount of the appropriations, is, therefore, reasonably attributable to the park program."

Self-Support.—One of the outstanding results, remarked Mr. Downer, has been the attainment of a "self-supporing maintenance basis," by virtue of rentals, concessions, etc., for the use of the recreational and amusement features of the park system. He then quoted the following statistics to "show the rapid trend of earnings toward completely balancing the operation and maintenance budget:

Year	Park Operation and Maintenance Budget	Income from Park System	Net Cost of Operation
1922	$ 25,000.00	$ 272.50	$ 24,724.50
1923	54,000.00	126.00	53,874.00
1924	258,309.33	46,191.98	212,116.35
1925	529,529.99	60,944.40	468,585.99
1926	733,103.33	313,102.75	420,000.58
1927	750,125.28	462,518.98	287,606.30
1928	1,202,958.93	1,142,803.36	60,155.57

"Although 29 miles of modern parkways and an extensive system of recreational projects were in operation in 1928, the net cost of the county was only $60,155. The parkways yield no direct income, but are of incalculable value in the saving of time and in convenience and safety for the traveling public.

"An Early Success.—Although the importance of a regional park system as an item of major importance in planning for the future growth of Westchester was clearly foreseen, considerable courage was required to launch it as the largest scale improvement program ever undertaken by the county. But officials and leading citizens had full confidence that the ultimate results would amply justify the enterprise. The results which are shown by the foregoing balance sheet, frankly, have been attained in a much shorter period of time than originally was anticipated.

"The demonstration afforded by Westchester that the idealism of a well-conceived planning program may rest on a sound economic basis is providing stimulus to many other municipalities both in this country and abroad."

Parkway vs. Trunk Highways.—As any one familiar with the Westchester work would readily realize, the parkways are one of the fundamental factors. Perhaps this work is as widely and favorably known for this one feature as for any other. Certainly, these parkways seem to be one of the basic ideas or backbones of the entire work. Mr. Downer explained the underlying purpose of this part of the work, as follows:

"We are building parkways in Westchester instead of great, new trunk highways. This has been a fact which has been stressed at city planning conferences during the last two years by some of our eminent, far-thinking city planners, which is now getting into the public consciousness; the fact that we do not want to spend all our money on wide state roads, that we cannot afford to build too many super-highways, which are simply wide slabs of concrete without protection of frontages. There has been a good deal in the papers about that during the last few years, and if you knew as I do how many people are now coming to our office to study that feature—the distinction between a parkway and a broad state highway—you would realize that that is something to reckon with.

"In other words, the people are beginning to demand protection of frontages on these expensive improvements, not only that the improvement itself may be enjoyable instead of a disfigured thoroughfare, disfigured by cheap stands and billboards and tawdry business development, but that the improvement may eventually pay for itself in its influence upon the zone which it serves.

* * * * *

"New Locations Cheapest.—Another thing we have found in Westchester is that it seldoms pays to lay out a great traffic route by widening an existing road. I am speaking now, of course, of suburban areas where you have a great deal of vacant land, only sparsely developed, which could be utilized for new routes. We found in Westchester after starting out many times to widen highways, that we could always, or in most cases, get 200 or 300 ft. in back somewhere cheaper than we could get 20 or 30 ft. to widen an old highway where the frontages were improved, and where you would pay for damages in cutting off fronts of fences, front gates, dooryards, etc.

"So we went in behind, where land was donated; a great deal sold at prices below the market in order to entice the improvement. We have there not only a wide parkway instead of an 80-ft. road, but we have controlled frontages, we have a great deal of restriction on the adjoining property, and we have controlled, to a very large extent, access drives and crossings so that these can be developed as fast trafficways with the greatest margin of safety."

Pouring Asphalt Joints in Brick Pavements With a Pressure Distributor

Method Used on Recent Paving Jobs at Flint, Mich.

By H. C. McCLURE
City Engineer, Flint, Mich.

A BRICK paving job recently completed in Flint has several interesting features. The job, known as the North Saginaw St. improvement, called for a pavement 74 ft. wide between curbs. The street was paved an entire new brick surface for a portion of the distance, and with new 27-ft. strips outside of the street railway track space, for the balance. In all, paving totaled around 60,000 yd.

The specifications called for an asphalt joint filler to comply with state highway specifications for this product, the contractor finally decided on "Texaco 39" for the work

Because of the location of this job, it was deemed advisable to eliminate as much interference on the street as possible, and to reduce complaints and nuisances on the street. The suggestion was made to the contractor that he secure his asphalt in insulated tank cars, ship them directly to the engineering department siding where plant steam would be available, and then use a distributor tank truck for applying this filler. This suggestion was adopted and worked with more than the expected degree of success.

Handling Asphalt from Tank Car to Street.—The asphalt reached the plant siding at a temperature of 175° or above, and required only about four hours of plant steaming to make pumping into the distributor possible. A distributor truck, manufactured by the Hendricks Co. of Morenci, Mich., was employed for this work. This distributor carried a jacketed pump, operated from a power take-off, which not only fills the tank but circulates or discharges the asphalt, as well, by means of a 3-way valve control. The distributor also carried an air compressor, a portable coal oil torch flame, and two coal oil oil-burner nozzles for heating the asphalt when in transit to the street, or maintaining the asphalt at any desirable temperature. An ordinary fan shaped nozzle was used for applying the asphalt directly to the street, the 3-way valve being opened just a sufficient amount to give the desired quantity for the work at hand.

Joint Pouring Rapid Operation.—Three men on the squeegees were all that were required for the street end of the work, the nozzle man and truck driver being furnished with the distributor outfit. These five men handled without difficulty all of the asphalt joint material on this and some other local jobs, without any difficulty whatever and with far less actual work and inconvenience to themselves, and with far less inconvenience to the street residents than is usual in such cases. When the brick surface was laid far enough in advance, it was possible to easily pour three full tanks (700 gal. each) in a single day, and cover in excess of 2,000 yd. of surface. This pouring operation was so fast that the outfit was unable to operate for continued runs of full days, but was required to cut down to two tanks per day quite frequently. Instead of being one of the slow, cumbersome, troublesome operations, the joint pouring became the most rapid operation and least inconvenient on the job.

Advantage of the Method.—Aside from the advantages to the workmen and to the residents, we believe that the advantage to the job was without question a decided one. The material was maintained within a temperature range of less than 250°, regardless of outside temperature and regardless of the amount of material in the tank. It was absolutely uniform in every physical characteristic, no coking or continued overheating changing it in the slightest. By applying directly at the desired point, and following immediately with the squeegees, an excessive amount was not left on top of the brick surface, yet all joints were completely filled. Estimates made on numerous occasions, indicated 1 1/3 gal. or less per square yard of surface.

Unloading Asphalt from Insulated Tank Car Into Distributor Truck

During the progress of the job, sudden summer showers occurred, yet these caused no inconvenience whatever because the pouring operation could be stopped instantly; and on occasions when the rain continued, the distributor was merely drawn back to the yard and the remaining portion in the tank pumped back into the tank car. With this extreme flexibility of operation, the pouring operation could be continued at various points along the job, with only a few seconds' lost time in moving the truck ahead; and a half hour's pouring in one portion of the work required no special set-up and could just as easily be taken care of as a full day's pouring at another section of the job.

Cost of Operation.—The contractor

Applying Filler to Brick Pavement Direct from Distributor Truck. The Asphalt Is Worked Into the Joints by Means of Squeegees

was able to purchase the asphalt in tank cars at approximately $4.00 under the drum price, less 60 ct. a ton for the insulated tank cars. The distributor operator took care of the heating, transportation and applying of the asphalt—including the distributor nozzle man and truck driver—for $12.50 per ton. The three squeegee men were paid $4.50 and $5.00 per day. These items represented the entire cost of this operation on the job. There was no lost labor, even in event of unfavorable wheather, because the three squeegee men could be easily used elsewhere on the job. There was no expense of street heating, and absolutely no expense in the item of clean-up.

From the standpoint of this office, we would say that the work as we had it outlined at the start, proved to be unusually successful, both from the contractor's and city's and the residents' viewpoint. There was no more expense in taking care of the work, and the absolute uniformity, flexibility and dependability of this portion of the job recommend this method, we believe, very favorably to work of this character.

Excess Condemnation Authorized in 11 States.—Excess condemnation is already legally authorized by constitutional amendment or otherwise in 11 states.

$100,000 Traffic Survey for New York.—A traffic survey has been authorized for New York City that is estimated to cost approximately $100,000.

Cost of 48-In. Water Main at New Bedford, Mass.

During 1928 the Water Board of New Bedford Mass., constructed a 2,561-ft. extension of a 48-in. cast iron pipe for a main. The work was done by the forces of the board. The pipe was Class "C" N. E. W. W. A. specifications and cost $38.20 per ton. The following detailed costs of the work are taken from the 1928 report of the Water Board, of which Stephen H. Taylor is superintendent.

	Total	Per Lin. Ft.
Pipe and Specials and Inspection	$31,267.71	$12.21
Leadite and Gasket	881.00	.34
Tools and Repairs	3,879.72	1.51
Labor (see sub-division)	11,324.30	4.42
Fuel, Oil and Grease	1,118.21	.46
Piles and Piling	1,388.58	.54
Akron Tile Drain	1,854.93	.73
Sand, Cement and Gravel	105.40	.04
Culverts Roaring Brook	908.81	.24
Two Wooden Box Culverts	405.62	.27
	$53,134.28	$20.76
Labor Sub-division		
Unload and Distribute 48-In. C. I. Pipe	$ 606.92	$0.24
Excavation and Laying	3,565.21	1.38
Backfill	**3,428.59	1.34
Pumping	758.65	.30
Clearing	469.51	.18
Watchmen	916.21	.36
Repair of Second Hand R. R. Dump Cars	*1,197.10	.47
Miscellaneous—Line and Grade, etc.	382.11	.15

*Four second-hand dump cars purchased for $600 and repaired at an expense of $1,197.10. represent a saving of about $1,500, as compared with the cost of new cars. They have been so thoroughly overhauled and repaired that they are now in every way as good as new.

**This figure includes labor only for that portion of backfill borrowed and hauled by dump cars from gravel pit about one mile from the site. It covers the labor for excavating borrow, loading cars, hauling cars, rehandling with clamshell at the pipe and hand grading. The total borrow was 6,660 cu. yd., and it required 41 working days to handle it. Average cost, labor only, $0.515 per yard; average 162 yd. per day.

Now Building Superhighway at Washington

The newest contribution to the growing exhibit of superhighways and parkways is the Mt. Vernon Memorial Highway, which properly belongs in the latter class, soon to be built between Washington and Mt. Vernon, Va.

The Memorial Highway will be placed on a strip of land 200 ft. wide. At first, a 40-ft. pavement will be constructed, with additional hard surfacing to be laid later when traffic demands it. The roadway will be more than 15 miles long.

Grade intersections with railways and all other heavily traveled roads will be entirely avoided by means of overpasses and under-passes. Further insurance against accidents will be given by the establishment of well-kept dirt shoulders extending 10 ft. on either side of the pavement.

Another modern note will be struck in the construction of seven or eight ornamental bridges. These are to be built to a width of 60 ft., which will preclude traffic jams and accidents common to narrow structures.

By means of fast moving machinery, the highway will be completed by 1932 in time to be dedicated at the celebration of the 200th anniversary of the birth of George Washington. Work of preparing the roadbed has already started.

Landscaping will progress along with the construction work, so that shortly the builders will have achieved their purpose of making the Memorial Highway one of the most beautiful in the world. Neat parking places will be provided between the highway and the Potomac river.

Trees on Watershed Areas

A watershed-protection program initiated by the Denver, Colo., Chamber of Commerce three years ago has resulted in the planting of about 20,000 western yellow pine seedlings on watershed areas close to the city, according to a report to the Forest Service, United States Department of Agriculture. The work has been carried on with the cooperation of various young people's organizations. Last year, for example, 2,000 seedlings were planted by boys of the Order of De Molay in Red Rock Park; 1,000 by the boys of the senior class of Manual Training High School, in Dicks Park; 1,000 by the Camp Fire Girls, on Inspiration Point; and 1,000 by the Garden Club of Denver. The three years' plantings, which have been made in various locations and under varying conditions, show an average survival of about 65 per cent. These results have encouraged the forestry committee of the chamber to develop a program of planting for the whole of the city's watershed.

Essential Requirements for Adequate Street Transportation

A General Statement of the City Traffic Problem

By HAROLD M. LEWIS
Executive Engineer, Regional Plan of New York City and Its Environs

THE highway traffic problem is a new one created by developments of the last 15 or 20 years. Within this period has been the greatest growth in the use of motor vehicles. In 1895 there were only about 300 motor vehicles registered in the United States. In 1915 this had increased to about 2,500,000, and in 1926 the total was over 22,000,000. Today there are probably almost ten times as many motor vehicles used in the streets of our country as there were in 1915. The startling part of this record of growth is that it has not yet shown a downward break. There is now one car for about every five persons in the United States.

This remarkable growth in the new method of transportation has required new developments in the types, number, arrangement and functions of highways. Streets that were previously adequate have now become almost hopelessly congested, and public officials, engineering and other experts, those operating public conveyances, and the motor-riding general public are all trying to find some means of providing adequate facilities.

The traffic problem first proved too much for the old types of roadway surfaces. Waterbound macadam and other light and inexpensive road surfaces have given way to heavier and stronger pavements, not only on the main business streets, but also on that network of trunk line highways which now connects all communities of appreciable size. Only 15 years ago, dusters and goggles as a protection against dust were almost essential parts of the equipment of every motorist, who expected to have to hang on when going over the rough places in order to prevent banging his head against the top of the car. The modern smooth and dustless highway has changed all this in a remarkably short time.

Following the breakdown of highway pavements there came an inadequacy in roadway widths. As a result, trees, strips of parking and wide sidewalks have been sacrificed to permit a widening of roadways and a greater capacity for vehicular traffic. Then, to add insult to injury, we have often doubled or tripled the average heights of the buildings fronting on these same streets, with a corresponding increase in sidewalk requirements, and the excess pedestrians have had to get along on the narrower sidewalks.

In many cases, roadway widening has not proved sufficient, and expensive projects for acquiring adjacent property and increasing the widths of highway rights-of-way have often been necessary. Such costly methods cannot be continued indefinitely. Some way must be found of curing the disease without an ever continued changing of facilities laid out before the motor vehicle era.

There are two principal methods of providing adequate street transportation:

1. Better use of existing facilities.
2. The addition of new types of facilities.

He who argues that only the first of these is needed is short-sighted, and he who would depend only on the latter is extravagant and impractical. Any real solution must be based on both. A brief summary of the most important of the various kinds of facilities in each class may help to indicate how they can be co-ordinated.

Better Use of Existing Facilities

Traffic Control.—The two principal effects of early traffic congestion were delay and an increase in the number of accidents. Traffic regulation and control were instituted to alleviate these conditions. The police department being in most cases already on the job was naturally called upon to aid in such activities. Within recent years the control of street traffic by manual or mechanical means has become a specialty which has received the careful attention of experts in this particular line. The synchronized "Stop" and "Go" system has been followed by various types of progressive systems designed to permit a continuous movement.

Records of the number and speed of vehicles were made by the Regional Plan of New York and Its Environs on typical Manhattan streets in 1924. These included 983 observations over stretches of roadway from four-tenths of a mile to one mile in length. The average weighted velocity of all observations was 11.3 miles per hour. When the velocity exceeded 11½ miles per hour, the average traffic was only about 200 vehicles per moving lane per hour. This was on streets which could have carried from 400 to 750 vehicles per moving lane, depending on the roadway width and obstructions therein. This shows quite clearly that there was a considerable amount of unused street capacity in New York City at that time, which a much greater efficiency should make available.

Maximum speeds permissible have recently been increased on many of our state and county highways, where 35 and 40-mile speed limits have superseded those of 15 and 25 miles per hour. But within our cities what is needed is not so much a greater maximum speed but a greater average speed. What is gained by moving 25 or 30 miles per hour, when traffic stops and delays reduce the average speed to less than that of a pedestrian? At times of peak loads on Fifth Avenue in New York City, average vehicular speeds of 2.5 to 3 miles per hour are not uncommon, and similar conditions are found in other cities.

More study must be given to the intersections and to the movement of both pedestrians and vehicles at such points. The pedestrian has until recently received little consideration.

Truck Loading Facilities within Property Lines.—Establishments which handle a large amount of trucking are the most serious offenders in regard to the use of streets for private purposes. Large modern trucks standing in narrow roadways during the loading or unloading of merchandise are a very serious obstruction to traffic movement. In many cases the merchandise monopolizes the sidewalk space. Many large and enterprising concerns have voluntarily installed loading facilities which permit such trucks to stand upon private property. These concerns have found that the savings to themselves have justified such expenditures. This in itself indicates that the compulsory provision of such facilities would be warranted.

Similar provisions should also be made for passenger vehicles by hotels, department stores and any concerns which cater to large numbers of persons using motor vehicles in going to or from their doors.

Night Deliveries.—Even a casual study of the variation in motor vehicle traffic during the 24 hours of the day indicates the great increase in capacity which would result if the peak loads could be reduced and the traffic spread more evenly throughout the day. There are many types of wholesale products

or large deliveries of coal and other retail products which might well be delivered to the business areas during night hours.

The express companies and other concerns have long realized the savings in night trucking, and have practiced it to a considerable extent. Some large department stores move their goods at night between their main stores and warehouses, and their sub-depots in the outlying parts of the city. A more universal knowledge and practice of this type of service would do much to provide adequate daytime transportation for vehicles which must move in daylight hours.

Consolidation of Trucking.—Considerable reduction in the number of vehicles using the streets may be accomplished by a consolidation of trucking routes and trucking service. This would do away, to a large extent, with the necessity of only partly loaded trucks making their many separate trips to isolated points. Store door delivery by the railroads between their rail terminals and shipper or receiver is a useful type of trucking consolidation which has been practiced successfully in England and Canada. Joint motor truck freight terminals for L. C. L. freight is another method which would do much to reduce the number of trucks upon our city streets.

Parking.—The parking of an owner's car in front of his premises on a little used street presents no hardship to his neighbors or the traveling public, but the wholesale parking in front of anybody's property has brought about a very serious problem in the down-town sections of all American communities. The limitation of parking time by municipal ordinance naturally resulted, but has not completely solved the problem, and has emphasized the need for adequate parking facilities accessible to the business districts.

Street space is too valuable to serve as a garage. In many cases the municipalities have at public expense provided considerable areas for the parking of motor vehicles. In general, the provision of terminal storage garages, by private enterprise on the edges of the business district, seems to be the only real solution of this problem.

The Addition of New Facilities

In our developed communities we must doctor up the present highway system, as best we can, to make it serve the modern requirements. Where opportunity permits the laying out of a new street system, it can be better adapted to the motor age. The percentage of space devoted to streets in the average city is about 20 to 30 per cent and is probably sufficient. The traffic problem has arisen because this space is not properly distributed. The wholesale use of the motor vehicle, coupled with the practice of erecting tall buildings for office and other business purposes, demands that business streets be much wider than residental streets.

The checkerboard street system inflicted over large areas on so many of our American cities did not distinguish between business and residential streets, or through traffic streets and local streets. In many cases residential streets, where the use of the land is permanently fixed by zoning restrictions, can be narrower than they are today.

General Traffic Streets.—The modern street plan should distinguish between traffic streets and local residential or business streets, and design each for its prospective needs. In the residential sections the street which is not subject to the noise and inconvenience of continuously passing motor vehicles has many advantages for residential purposes. The main traffic streets should preferably run in pairs, especially where surface transit facilities are to be provided. What would it be worth to Philadelphia today if Broad St. was paralleled by a street of equal width within a few hundred feet? Many of us have been subject to long detours and delays because a main highway was under repair, and there was no adequate parallel street to which traffic could be diverted.

There is a practical limit to the widths of roadways. Within our cities four or six moving lanes of traffic on a single roadway are about the maximum desirable. Beyond that, an inefficient use of the lanes caused by a shifting of vehicles from one to the other, and the increased difficulty and danger for cross traffic, both vehicular and pedestrian, bring many disadvantages. To get the maximum efficiency of roadway space it should be divided by curbs into sections of a two-lane width, and these subdivided by lines upon the pavement into separate traffic lanes.

On highways outside the city limits, four moving lanes probably offer the most efficient facility, and where greater capacity is required, duplicate roadways are preferable to a single wider roadway.

Boulevards.—Reference has already been made to the reduction of strips of parking which has resulted from increased traffic demands. A comprehensive boulevard system is an asset which every city should attempt to gain and keep. Such streets are essential if cities are to be kept attractive in appearance, and they form the natural boundaries for residential units. A modern boulevard should have a right-of-way of not less than 160 ft., and should preferably be 200 ft. in width.

In many cases, boulevards may partake of the nature of super-highways connecting adjoining cities, such as have been developed in the neighborhood of Detroit, where a 204-ft. right-of-way has been used. Streets of this kind, linked up with by-passes around the larger communities, would form an almost ideal circulation system for long-haul vehicular traffic.

Parkways.—Parkways originally were essentially parts of the park system, and as such were mainly for local use. With the great increase in motoring as a means of individual transportation and as a recreation, the function of parkways has been expanded. As being developed in Westchester County, New York, parkways serve four purposes:

1. They provide park space for local recreation, and connect up large park areas which serve as country parks.
2. They serve as corridors of open spaces between built-up communities, and help to maintain the integrity of suburban centers with local interests and activities.
3. There are constructed through them highways reserved for passenger vehicles, and providing a pleasant and speedy means of travel between the metropolitan areas and the open country.
4. When coupled with proper zoning restrictions, they stabilize high class residential developments in attractive surroundings.

Grade Separation.—It has already been pointed out that traffic interference at street intersections is the primary cause of the inefficient use of existing roadways. This can probably be relieved to some extent by improved methods of control and better design of the intersections. A sure cure can be obtained by the separation of highway grades so as to permit uninterrupted movement in all directions. Unfortunately this method is often so costly in highly developed areas as to be prohibitive. But at certain key locations it may be expedient although costly. There are many places on the outskirts of the congested districts where such a method could be carried out at important intersections at a reasonable expense.

Realizing the great advantages of grade separation, the Topographical Bureau of the Borough of Queens, New York City, has advocated the future separation of grades by the depression of one of the roadways at many important crossings. To facilitate this, they propose the immediate acquisition of a "width of right-of-way from 130 to 160 ft. for a distance of from 300 to 500 ft. on each side of the highway intersection, for the road which is to be depressed."

Zoning and Its Relationship to Highway Facilities

Building Bulk and Highway Traffic.—Intensive building cannot be carried out over large areas without causing an impossible traffic burden on street systems already fixed by existing developments. Zoning offers about the only hope of keeping such building operations within suitable limits. There is obviously a relationship between the bulk of buildings that can be placed in a given area and the capacity of the

streets which serve as a means of access to them. Buildings of large bulk must be balanced against extremely low buildings or open spaces. But vehicular traffic caused by any building is not directly proportional to its bulk, as its type of use is an important factor. Mr. Ernest P. Goodrich, Consulting Engineer, has worked out figures showing that the relative vehicular traffic to and from buildings used for retail business, garment industry in loft buildings, and offices varies in the ratio of 4 to 12 to 21.

That this situation is realized by business and industrial leaders as well as city planners is indicated by the following quotation from an article by Mr. Irving T. Bush, president of the Bush Terminal Company, New York City:

"The sensible thing to do is to limit the floor area on each given plot. This can be done either by establishing a uniform, maximum height of building or by permitting an irregularity of height, but with the provision that a no greater number of square feet of floor space be permitted upon each lot."

An analysis by the New York Regional Plan staff of the relation between building bulk and highway traffic in southern Manhattan, New York City, indicated that if every land owner in this district were in the near future to erect buildings merely to the cornice heights, as permissible under the zoning law, there would be a volume of local traffic nearly 70 per cent in excess of that which it is estimated the streets could carry. And the setback and tower provisions of the New York City Zoning Resolution permit building bulks far in excess of those used in this computation. Therefore, if the present street system in Manhattan is to serve the buildings within the business sections, some way must be found of keeping the average height within those areas well below that now legally possible.

Influence of Land Uses.—There is a tendency to consider every arterial street as a potential business street. In many cases they have been zoned throughout for business. The result has been that property fronting on such streets has been held by real estate dealers at prices prohibited for residential purposes, and residences have first been built upon those side streets where more economical lots could be obtained. The development of property along the arterial streets has thus been held up until a sufficient residential development had taken place in the neighborhood to justify the construction of business buildings.

A more economical arrangement might have been obtained by designating certain isolated sections of the main street for small business centers to serve local residential communities. The balance of the avenue might well have been zoned for residence, with a sufficient set-back line to assure that the houses would be far enough removed from the noise and dust of the vehicular traffic to provide satisfactory places of residence.

Set-back lines are particularly valuable along streets which may later have to be widened as the area builds up and traffic increases. They permit such a widening without the costly and often prohibitive expense of tearing down buildings.

A Plan for Adequate Street Transportation.—While all cities have their traffic problems which contain many similar elements, no two cities are exactly alike, and therefore there is no standardized cure which can be applied. There are standard principles which will be of help, but their application is necessarily different. It is therefore essential that, before a plan can be adopted to provide adequate street transportation for a given community, a careful traffic survey be made for that community. The type of material to be included in such a survey is beyond the scope of this paper, in which an attempt has been made to set down some of the methods of solution which should be considered in drawing up a comprehensive plan for vehicular traffic after the survey is completed.

As has been pointed out, such a plan should combine (1) the improvement of existing facilities by new regulations, supplemental additions and such changes in existing facilities as may prove economically feasible with (2) the addition of new traffic routes adapted to modern requirements, and designed to provide for estimated future needs.

A properly prepared zoning plan can be of inestimable advantage to any community. By a careful co-ordination of its provisions with the traffic plan, it can do much to maintain a proper relationship between the buildings within a city and the streets which must both serve those buildings, and also permit an easy flow through the city of all that vehicular traffic which modern ways of living and doing business bring within its gates.

Acknowledgment.—The foregoing is a paper presented at a symposium on "Expediting and Controlling City Traffic," held under the auspices of the Engineers' Club of Philadelphia.

Percentage of Rural Population Declines.—In 1880 our rural population formed 71 per cent of the total; in 1925 the proportion was only 45 per cent. Yet there are 18,000,000 more people in the rural districts of the United States today than there were 50 years ago. Farm acreage has increased from 536,000,000 to 924,000,000, and the value of farm property is nearly five times as great as it was in 1878. Half a century ago the value of all American farm products was less than $2,250,000,000 yearly—while by 1925 it had risen to more than $13,000,000,000.

Public Purchases of Materials for Municipal Work

To the Editor: In you issue of November, 1928, I note an article on "Public Purchase of Materials for Public Works" to be furnished to contractors.

It may be of interest to your readers that the Metropolitan Water District of Manila, Philippine Islands, used these methods for many years, on certain classes of materials, especially since the extension of our system which was started a few years ago, and which will cost some eight or nine million dollars, went into effect.

Our procedure varies for various materials and is approximately as follows:

Cement: We buy large quantities of cement and test it for our own account and deliver it to the contractors at our storehouses, at practically cost price. The contractor transports it to wherever it may be needed at his own costs, and stands all losses due to damage, etc. In his charges per cubic meter of concrete, he naturally includes the cost of the cement. Cement used up every half month, as per his report verified by our engineers, is deducted from his 15-day estimate of work accomplished.

Cast Iron Pipe, Specials, Valves, Etc.: We buy ourselves under separate arrangements, and the contractor is paid whatever he bids, per ton, for transportation from our yards, installations, etc. If any material is damaged, through contractor's fault, we charge him the cost of materials.

Steel Plates for Pipes, Etc.: We purchase the plates to our specifications, and pay contractor for transportation, manufacture and construction. We intend to do this in the future with reinforcing steel, whenever large quantities are to be used. The drainage pipes for our filter system were drilled and plugged in our own shops and delivered to the contractor ready for use. We find it very advantageous, as we can secure lower prices in purchasing materials, borrow our money at about 4½ per cent, while the contractors here would have to pay 9 per cent per annum, and can buy the material we wish and avoid arguments with the contractors. The contractor is helped out considerably as it reduces his financing troubles, and does not have to worry about his materials.

We never had any trouble about non-arrival of materials on time, as we make sure to order the materials before they are needed.

A. GIDEON,
Manager and Chief Engineer, Metropolitan Water District, Manila, P. I.

Purifying Acid Mine Water

The Kaplan-Reger Process

THE West Virginia Geological Survey has recently completed a process for the purification of acid coal mine waters. Generally speaking, it consists in adding to the sulphate waters from coal mines a complex organo-metallic compound which combines with the chemical compounds of the waters and forms a blue pigment to be known as Monongahela Blue and at the same time removes the acid. By certain mainipulations the color of the pigment may be varied almost at will, producing beautiful shades of blue, green, and red. These are not aniline dyes, but are mineral pigments.

Numerous Variations Possible.—Numerous variations of the process are possible and it has not been determined which of these several manipulations may prove to be most successful or profitable, but in general the use of the process at any given point will depend on whether water purification alone is desired or whether the recovery of chemical by-products is the main consideration. In the first case, if purification is the main object, the original cost of the reagent need be no obstacle. The pigment recovered has at present a market value approximately 100 per cent greater than the reagent added and would normally be sold at a profit. If more pigment should be manufactured than can be absorbed by the market, however, it could be decomposed with the regeneration of the organo-metallic reagent and another pigment of less value recovered. By this method the organo-metallic reagent would be used many times with only a trifling loss on each operation. In the second case the more highly saturated waters would be treated for commercial recovery of Monongahela Blue and other products and water purification would be incidental although very effective.

Detailed Studies Necessary for Different Localities.—In order to determine the most practicable method of handling mine waters in different localities it will be necessary to make detailed chemical studies at all such points so that particular recommendations can be made regarding what can be done. The experiments so far made have been confined to certain mines in the Scott Run region near Morgantown, where conditions appear to be specially favorable for use of the process. It is believed, however, that the waters derived from the Pittsburgh coal of the Monongahela Valley in West Virginia, and from the same coal mine waters in western Pennsylvania and eastern Ohio will prove suitable for use in strictly commercial plants at many favorable points. So far as observed the water from the Sewickley coal has proved to be alkaline and not readily susceptible to this method of treatment. At the same time, however, this water is much less corrosive and therefore less objectionable in the streams, its principal impurities being calcium and magnesium sulphates which make it hard and troublesome for laundry and bathing purposes.

In regions where the sulphur content of the coal is very low it is not at present supposed that enough chemicals exist in the mine waters to make treatment either necessary or profitable, but further exhaustive study will be necessary to establish or disprove this theory. The Geological Survey has no present plans for work on low sulphur mine waters, as its funds and personnel are too limited to engage in a general investigation outside of the high sulphur districts.

Recovery of Chemicals Commercially Possible.—In the high sulphur regions where mine waters are acid it is believed that the recovery of chemicals will prove to be so profitable that their exploitation will be pushed by the larger mining or chemical companies to the great advantage of those concerned either by way of mine water ownership or by participation in these manufacturing enterprises, and also to the almost equally great advantage of the communities which must now make domestic use of these polluted waters. It is expected that the Monongahela Valley of West Virginia, in particular, will be specially benefited by the discovery.

The study of coal mine waters has occupied the attention of industrial and public health chemists for many years, but in general their conclusion has been that no profitable process for utilizing these dissolved chemicals could be devised and that little could be done toward purification except to neutralize the acids by the addition of lime which at the same time makes the water hard and in some respects more objectionable. Federal chemists have estimated that four or five tons of water are produced for each ton of coal mined and that in Pennsylvania alone 9,000,000 tons of sulphuric acid are dumped annually into the streams. In the Monongahela Valley of West Virginia chemists of the university have figured that the acid mine drainage of 50,000,000 gal. per day. On the basis of 200 grains of acid per gallon the river receives about 250,000 tons of acid annually. These figures give some idea of the pollution problem.

How Process Was Discovered.—In 1919 David B. Reger, now Acting State Geologist, collected a few samples of mine waters on Scott Run and had them analyzed in the laboratory of the Survey in the hope that some profitable use might be made of them, but no such result was achieved, as the Survey was then poorly equipped for such an investigation. In the summer of 1928, after he had become its acting head, the Survey installed a new chemical laboratory with facilities which made possible a resumption of the study. In August of that year Mr. Reger and Dr. B. B. Kaplan, chemist of the Survey, again began the collection of acid mine waters, which were then subjected to exhaustive analyses and experiments by Dr. Kaplan, resulting in the rapid development of the process above mentioned. To those who have been permitted to witness the production of Monongahela Blue and other valuable compounds by Dr. Kaplan in his laboratory the results are declared to be a brilliant achievement of unusual merit, capable of bringing to West Virginia a valuable chemical industry and at the same time ridding the state of a grave menace to its water supply.

For convenience it has been styled the Kaplan-Reger Process, giving first honor to its chief technician, Dr. Kaplan, and at the same time recognizing the original conception and personal cooperation of Mr. Reger. Patents are now pending in Washington to cover the process, as it is not considered advisable to permit indiscriminate or irresponsible chemical manipulations on water which may be used for city supply at some down stream point. Under proper chemical supervision there is no danger that any deleterious agent may enter the water. On the contrary the dangerous compounds now in it will be entirely removed. At some later date a detailed scientific description of the process will be prepared for the technical journals.

The Kaplan-Reger Process differs fundamentally from all other methods of treating acid water. In general the practice has been to use the so-called base exchange method which consists in substituting a less objectionable chemical for one which is distinctly injurious. This method is expensive and unsatisfactory since the chemicals are always lost and no by-products are recovered and since the highly saturated water foams in boilers and is otherwise troublesome to use. In the Kaplan-Reger Process, however, the added chemicals combine completely with the chemicals in the water to form an insoluble, marketable product, leaving the water practically free from acid and mineral substances.

Florida Water Works Men Meet in April.—The next meeting of the Florida section of the American Water Works Association will be held April 10 and 11, 1929, at Jacksonville, Fla. E. L. Filby, Chief Sanitary Engineer, State Board of Health, Jacksonville, Fla., is secretary.

The Sewage Disposal Plant of Aurora, Ill.

Design and Construction Features Outlined

By L. R. HOWSON
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THE Aurora Sanitary District was organized in 1926. The district boundaries include all of the city of Aurora and a small area outside. Quite recently, the district has been extended to the south along the Fox River in the village of Montgomery.

All of the sewage of this district drains to the Fox River, which flows diagonally through the center of the city. There is no sewage treatment now, with the exception of the Indian Creek District in the northeast section of the city, where in order to obviate the necessity of constructing an outlet sewer through deep cut, the city of Aurora constructed an Imhoff tank, the effluent from which discharges into Indian Creek and thence to the river.

While the flow in the Fox River exceeds 200 cu. ft. per second for approximately 97 per cent of each year, local nuisance has resulted from time to time and the objectionable appearance of the river due to the discharge of the raw sewage is noticeable a considerable portion of each year.

Soon after the organization of the district, engineers were employed to make a comprehensive study of intercepting sewers and sewage disposal. The investigation was made during the latter part of 1926 and the report was transmitted in March, 1927.

Population Study.—The total population residing within the district at the present time is approximately 50,000 people. The growth in population in the past has been relatively slow and gradual but in recent years, due to the influence of the Chicago suburban expansion and the greater industrial development of the district itself, the growth has been more rapid. It is believed that the population will approximate 75,000 people by 1940, 105,000 by 1950 and 170,000 by 1970.

The dry weather sewage flow at the present time is approximately 5,000,000 gal. per day, which it is estimated will increase to 7,000,000 gal. per day in 1940 and from 9,000,000 to 10,000,000 gal. per day in 1950. Analyses made of the sewage and of the wastes from the principal industries showed that it is what is usually termed "typically domestic." The industrial wastes are of relatively small importance as measured by their quality and the necessity for special treatment.

Period of Design.—In the making of the investigation, it was believed that intercepting sewers, which, for a considerable portion of the distance, must necessarily pass through the business district of the city which adjoins the river on either side, should be designed for the 1970 population of about 170,000 people.

Sewage disposal works which can be constructed on the unit plan were designed to care for 75,000 people and 6,500,000 gal. per day, the conditions forecasted for 1940.

Disposal Plant Site.—In the selection of a site for the disposal plant, the choice was largely dictated by topographical features. The low lying land in the Fox River Valley is usually limited in extent and the first available site downstream from Aurora was in close proximity to the village of Montgomery. An excellent site existed about one mile south of Montgomery, in which sufficient low lying land was available, not only for present requirements but for the indefinite future. Approximately 26 acres were purchased for the first construction. This site is about two miles south of the south limits of Aurora.

Intercepting Sewer.—The intercepting sewer is approximately 32,200 ft. in length and varies in size from 18 in. to 69 in. So far contracts have been let for 12,260 lin. ft. of 69-in., 6,270 lin. ft. of 54-in. and 370 lin. ft. of 48-in. Bids have been taken upon segment block, each bidder being required to submit a proposal on at least two types of manufactures of block. All of the sewers built to date have been constructed of the Meier block.

Perspective View of Sewage Disposal Plant of Aurora Sanitary District, Aurora, Ill.

The Meier block is a pre-cast segment block tile. The segments are single ring, vitrified tile which are formed on the bank into tile sections about 4 ft. in length. Adjoining segments have interlocking lugs which are filled with cement grout and which provide the strength necessary to hold the tile in circular shape. The tile are handled and laid in a manner similar to ordinary concrete pipe. Joints between adjacent tiles are made with cement mortar.

The experience with the Meier block to date has been quite satisfactory. The only difficulty experienced has been due to the unequal burning of the segment blocks and the variations in block, shrinkage resulting from this fact. This has, however, not been a serious difficulty, simply resulting in the necessity of using more mortar at the joints between adjoining lengths. The invert of the sewer is unusually uni-

Placing Sprinkling Filter Bottom

form as all irregularities have been taken in the top of the joint. All tile are bedded in concrete up to the springing line.

The sewer excavation has been attended by no unusual difficulties other than those incident to work of this type. It was necessary to remove approximately 7,000 cu. yd. of rock from the trench excavation. The sewer trench which parallels the river, practically the entire distance, has not involved an excessive amount of pumping, the invert of the sewer in its lower reach being slightly above river level for most of the distance.

The work to date has involved three river crossings which have been effected by the use of cast iron inverted syphons, each syphon being in duplicate or triplicate with inlet and outlet chambers so arranged as to maintain as high velocities as possible in each line in service before another line is added. Provisions are made for the blowing-off of any deposit that may accumulate in the syphons.

The sewer contracts have been let at low figures, the prices and the average cuts being as follows:

Size	Per Ft.	Average Cut. Ft.
69-in. sewer	$14.95	8.0
54-in. sewer	13.75	9.25
48-in. sewer	7.75	8.5

Manholes are of concrete and were bid at prices varying from $82.50 to $100.

Plans are now nearing completion on the additional interceptors, approximately 850 ft. of which will be of 36-in. cast iron pipe laid largely in the river bed or immediately adjoining it and below river level.

Sewage Disposal Plant.—In the preliminary investigation comparative studies were made of those means of sewage disposal ordinarily adapted to Aurora conditions. As a result of that investigation, a plant consisting of coarse screens, grit chamber, tanks of the separate sludge digestion type with mechanical equipment, sludge drying beds, pumping station and sprinkling filters was determined upon. Bids were taken in the early summer of 1928 and the work is now well over half completed.

Screens and Grit Chamber.—The coarse bar screens are of the mechanically cleaned type. The screen consists of steel bars ¼ in. by 3 in. spaced at 5/6 in. centers and with a raking device automatically controlled by the difference in water level ahead and behind the screen. As the screen becomes clogged, the cleaning apparatus makes one revolution, raking the material to a platform at the top, from which it is shoveled directly into a car.

The sewage after passing through the screen passes into a grit chamber which is of the mechanically cleaned type. The screen chamber is approximately 26 ft. square and has a normal water depth of 2 ft., giving a theoretical detention period of 2¼ minutes. The grit as it settles out is collected by a revolving mechanism of the clarifier type, but with squeegees so arranged as to push the grit to the periphery instead of the center of the basin. The grit is pushed out into the bottom of an inclined elevator provided with a mechanism which tends to carry the grit up an incline and wash out the organic matter which flows back into the sewage and thence through the plant. This grit is loaded into cars and used for filling. It is expected to be practically free from organic matter.

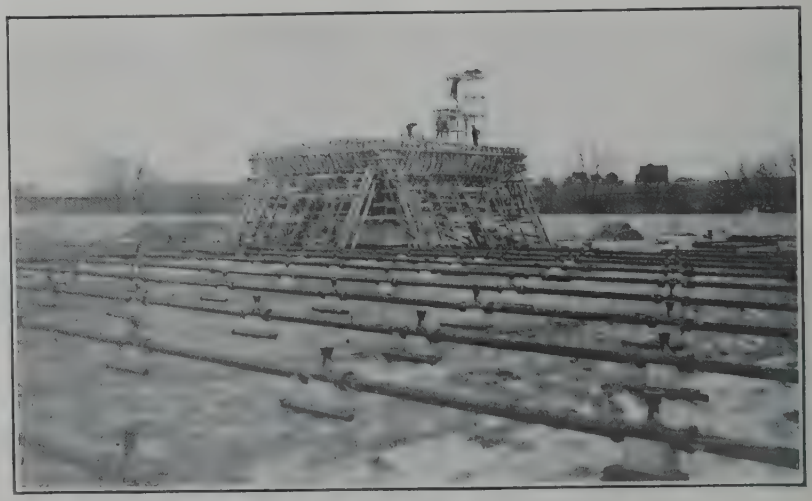
The mechanical screen and the grit chamber apparatus are furnished by the Dorr Co. The cost delivered, but not installed, is $2,450 for the screen and $5,600 for the grit chamber equipment.

The screen and grit chamber are housed in a superstructure of general architectural design similar to the office, pump house and tank structure.

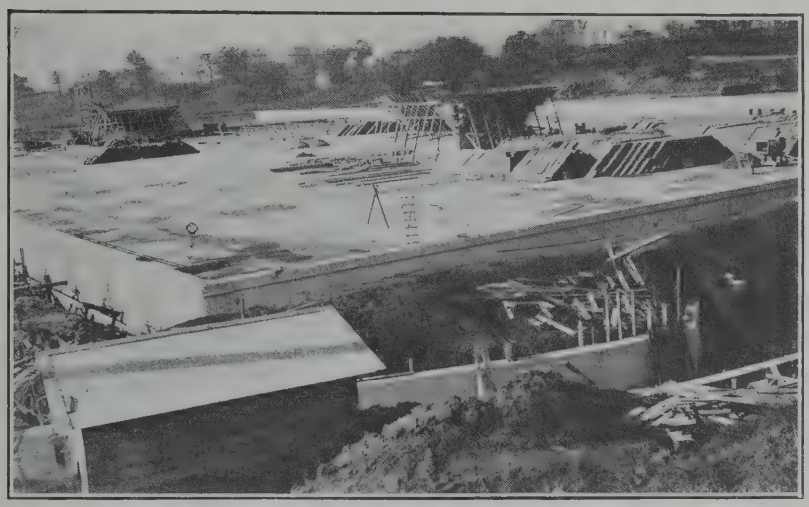
Tanks.—From the grit chamber, the sewage flows through a 48-in. sewer provided with a venturi meter to the settling tanks, which are four in number, each 50 ft. square by 11.5 ft. deep and which provide a detention period of three hours at the normal rated flow of 6,500,000 gal. per day. These basins are provided with Dorr Co.'s traction clarifiers. The tanks are provided with skimming devices for grease removal. This grease is pumped to a decantation tank in the screen house, where after separation from the water it is disposed of with the bar screenings.

The sludge is pumped from all tanks by a single sludge pump which discharges into any one of three sludge digestion tanks, each 50 ft. square by 16 ft. deep, the floor of which is placed approximately at the ground surface. These tanks provide capacity equivalent to 1.9 cu. ft. per capita served in 1940.

Gas from Digestion Process Used for Heating.—The sludge digestion tanks are covered with a concrete roof which is supported by the digester mechanism trusses and the exterior walls. The roof slopes toward a central gas dome



Sprinkling Filter, Floors, Dosing Tank and Distributors



3.6 Acres of Sprinkling Filters; Bottom and Pipe Supports Set in Background

4 ft. in diameter by 3.5 ft. high which is connected by gas piping to an ordinary gas fired hot water boiler located in the main building. The gas resulting from the digestion process will be collected and used for heating the main building and for heating water which will be circulated through the digesters to maintain as uniform and as high a temperature as practicable during the entire year.

The top of the digesters is covered with an earth fill and an embankment of earth surrounds all exposed walls. This is to assist in maintaining uniform temperature for digestion.

Each digester has a separate gas meter and all piping is so laid out as to permit of maximum flexibility of operation.

Sludge digesters may operate in parallel or series. All pumping and circulating operations are controlled from a central point.

The settling tanks which occupy an area of 50 ft. by 200 ft. are covered by a low housing of brick with stucco exterior and with a creosoted wood roof supported on steel trusses.

In plan, the pumping station, the settling tank superstructure and the sludge digestion tanks all adjoin and the superstructure is so designed that access to this entire part of the plant is had without going out of doors.

Pumping Station.—From the effluent channels of the settling tanks, the sewage flows to a suction well approximately 12 ft. by 51 ft. by 9 ft. deep. The sewage pumps, consisting of three units respectively of 6,000,000 gal. daily capacity and two of 8,000,000 gal. daily capacity, take suction directly from this well and discharge the sewage through cast iron force mains to the two twin dosing chambers. Operation of pumps is automatically float controlled. Due to the necessity of pumping settled sewage only, it is practicable to use closed impeller pumps with the resulting greater efficiencies. Each dosing chamber serves 0.9 of an acre of stone sprinkling filters. Each chamber is provided with a 24-in. single syphon.

Sprinkling Filters.—The stone sprinkling filters have a total area of 3.6 acres and an average depth of 6 ft. At the time bids were taken, alternate bids were received upon three types of underdrainage, namely, a valley and trough type of plain concrete floor, the "Rawn" underdrainage system and the "Metro" underdrainage system. As would be expected, the concrete underdrainage system was the cheapest. The Metro system bid was $9,600 per acre higher than the plain concrete and the Rawn system $11,700 per acre higher than the plain concrete The Metro system was adopted. The experience in laying this floor has been very satisfactory.

Contractors were required to submit samples of filter stone for testing. All samples were tested for soundness and ability to withstand alternate freezing and thawing, using the salt method, the immersion withdrawal and freezing method and the submerged freezing method. Of ten samples tested, but four satisfactorily met these tests which were conducted over a period of several weeks by the Engineering Service Company of Aurora.

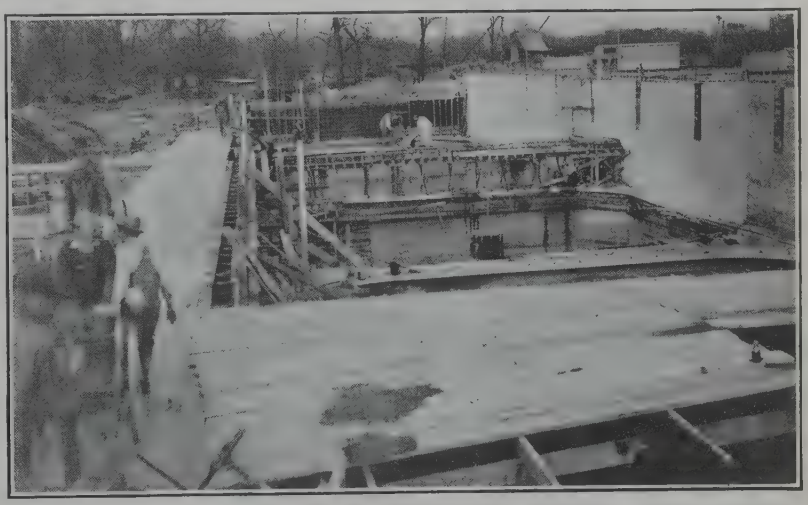
Pumping Station and Office Building.—The pumps are housed in a Spanish style building which is a part of a general structure housing the tanks proper. The pumping and administration building has a floor area of 42 feet by 76 feet. The building includes an office and laboratory, public toilets, switchboard room, heater room and two car garage. The exterior finish is of white stucco on rough brick. The roof is of Spanish tile.

Concrete Surface.—The specifications required that all concrete surfaces exposed to view should be rubbed while the concrete was still fresh with a carborundum brick. The effect thus produced has been unusually good. The writer is indebted to L. N. Fisher of Cope & Fisher of Decatur, Ill., contractors on this work, for the following construction outline:

"Various methods and times of producing the finished surface were tried. As eventually worked out, the forms are stripped in from 12 to 36 hours after pouring, all depressions and voids are then pointed up and a bush hammer is used to take off the worst of the form fins, although all ordinary form marks are left for the machine.

"In from 36 to 60 hours after the concrete has been poured, the entire surface is gone over with an air driven grinding machine. Two men are used on each machine, one to operate the machine itself and the other throwing clear water in front of the machine and pointing up with a trowel and hand brick after the machine."

The contractor advised that the cost of this finishing is from 9 ct. to 11 ct. per square foot of surface which is equivalent to about $2.50 per cubic



Pump Pit at Extreme Left; Clarifier Tanks in Center; Sludge Digesters at Right

yard of concrete based on a 12-in. wall thickness.

Mr. Fisher further advised that the best results are secured when the temperature ranges from 65 to 75 degrees. Higher temperatures result in the surface drying too quickly and with lower temperatures, the concrete does not finish up well behind the machine. If the concrete is allowed to go as long as 5 or 6 days before finishing the surface, the cost is increased approximately 100 per cent.

It is the writer's conclusion that the extra cost of this method of surface finish is well worth while. Relatively so small an amount of an intercepting sewer and sewage disposal plant construction is above ground that it is desirable to make that part as attractive as economically practicable.

Personnel.—The preliminary report, plans and specifications for the Aurora work were prepared by Alvord, Burdick & Howson. Mr. W. E. Deuchler, Chief Engineer of the Aurora Sanitary District, is supervising the construction through the Engineering Service Company of Aurora. Cope & Fisher of Decatur are contractors on the disposal plant. The intercepting sewers are being built by Ashton & Russell of Chicago and Kuehn Bros. of Aurora.

Acknowledgment.—The foregoing is a paper presented Jan. 23 at the 44th annual meeting of the Illinois Society of Engineers.

Elimination of "Red Water" with Soda Ash

After the completion of the new rapid sand water filtration plant at the Maryland House of Correction, at Bridewell, Md., considerable trouble was encountered with "red water," and tests were made to discover the cause. The recently issued report for 1928 of Abel Wolman, Chief Engineer Bureau of Sanitary Engineering of the Maryland State Department of Health, contains the following note on this work:

The tap water was found to contain appreciable amounts of free carbon dioxide and a hydrogen-ion concentration that was well on the acid side. Tests were made using sodium aluminate together with alum for coagulation and doses of 0.7 grain of alum and 0.2 grain of sodium aluminate per gallon were established. However, this did not entirely remove the trouble and further tests with lime and soda ash were made. Lime or soda ash treatment removed the carbon dioxide and increased the pH, but as the treatment with lime was less satisfatcory, due to the variable strengths of milk of lime and the danger of increasing the scale forming solids, treatment with soda ash was recommended. The recommendation was carried out and all trouble with "red water" was eliminated and improvement in the taste of the water was reported.

Cleveland Gets First Airport Convention

The first airport convention ever held will be staged in Cleveland, O., May 16, 17, 18, according to an announcement made today by Captain Clarence M. Knox, vice-president in charge of the Airport Section of the Aeronautical Chamber of Commerce. Mr. Knox, who is Commissioner of Airports of Connecticut, with headquarters at Hartford, said the airport convention would be an annual affair. His announcement follows:

"The Airport Section of the Aeronautical Chamber of Commerce will hold the first airport convention ever held, in Cleveland, May 16, 17, 18. A tentative program includes discussions and addresses on various phases of airport lighting, landing field construction and care, inter-field communication and meteorology, design and architecture, safety control, maintenance and administration, and standards of practice.

"In addition to the large attendance among representatives of airports from all parts of the United States," Mr. Knox said, "the convention will attract representatives of municipalities and civil organizations, engineers, architects, contractors and manufacturers whose interests in airport development and construction are assuming great proportions." The following have been appointed on the convention committee:

Chairmen:—Local Convention Program—Major John Berry, Manager, Cleveland Municipal Airport; Entertainment—B. E. Fulton, Manager, Fulton Field, Akron, O.; Registration—Gabriel C. Harmon, Manager, Trans-Continental Airport of Toledo; Membership—Clifford Henderson, Director of Airports, City of Los Angeles; Demonstration—E. A. Johnson, Operator Dayton Airport; Program—Harry Schwarzschild, Publisher Airports; and R. W. Whitney, Manager, Airport Section, Aeronautical Chamber of Commerce.

Information on any feature of the convention may be secured by writing R. W. Whitney, Aeronautical Chamber of Commerce, 300 Madison Ave., New York City.

Phenol Treated in New Way

The Ohio State Department of Health, according to its official publication, Ohio Health News, of March 1, has recently completed a preliminary report of an inspection of the by-product coke plant and phenol treatment works of the Pittsburgh-Crucible Steel Co. at Midland, Pa. This report is a result of one of the important departmental activities under the Ohio River Stream Conservation Agreement which is to conduct joint investigations, with representatives of other interested states, of industrial plants which discharge waste water into interstate streams or their tributaries, thus affecting down-stream water supplies.

The plant of the Pittsburgh-Crucible Steel Company is situated on the Ohio river immediately upstream from the Ohio-Pennsylvania state line and the water supply intake of East Liverpool, Ohio. The phenol-contaminated waste water from this plant, discharged to the Ohio river directly, formerly affected the East Liverpool water supply very seriously. This situation was brought to the attention of the State Department of Health of Pennsylvania by the Ohio Department of Health, and after due investigation an order was issued to the company by the Sanitary Water Board of Pennsylvania to correct the situation. As a result, this company has constructed a phenol treatment works using the Heffner-Tiddy process. This treatment works has been in operation since May 1, 1928, and it is stated that an efficiency of phenol removal of 90 to 95 per cent has been effected. In this case, the proof is in the drinking of the East Liverpool water, and in justice to the company it must be stated that so far the supply has been comparatively free from phenol tastes and odors.

It is to be noted that the waste water from the plant at Midland does not affect any water supply in Pennsylvania. The correction of this industrial waste problem was carried out at the insistence of the Pennsylvania Sanitary Water Board solely for the purpose of protecting water supplies in Ohio, West Virginia and other downstream states. The correction of this problem demonstrates the workability of the Interstate Stream Conservation Agreement on the Ohio river and indicates the benefits that may be derived by handling such matters in a co-operative manner with uniform administrative methods and policies.

Pocket Gophers Dig Up Airport

One of the finest municipal airports on the southern border, located at Douglas, Ariz., recently became infested with pocket gophers, which threw up more than 2,000 mounds of earth on the field, making the landing of planes difficult. The field is unique in that its southern border is the international boundary line between the United States and Mexico. The aviation committee of the city of Douglas requested the assistance of the Bureau of Biological Survey of the United States Department of Agriculture in clearing the field of pocket gophers and provided a crew of men to place poison and traps. Three days' work under the supervision of the bureau's leader of rodent control in Arizona resulted in complete eradication. The control operations were conducted in cooperation with the Arizona Agricultural Extension Service.

City Planning in Colleges.—There are now six colleges in this country giving city planning work as liberal arts work.

The Development of Traffic Control Engineering

New Field Offers Opportunities for Engineers

By MILLER McCLINTOCK
Director, Erskine Bureau, Harvard University, Cambridge, Mass.

THERE is probably no field of professional activity developing so rapidly as is engineering. The very great increase in the complexity of modern life, and especially in technical methods for accomplishing new results, has brought many new opportunities to the engineer during the last quarter of a century. Those who were connected with engineering practice twenty-five years ago see today the inclusion of many subjects which were never formerly contemplated as engineering problems. In no aspect are the complicated elements which come under the engineers' jurisdiction changing more rapidly than in American cities. The problem of street traffic is just one of many of the rapidly shifting conditions in current urban life. It is another instance of the important public problems which arise and need the kind of attention which engineers have been trained to give to problems of this character.

I am not going to give a technical talk tonight, or a formal one. I am going to think more or less out loud, and to tell something of the experiences I have been having the past few years, with the hope that I can give some idea of the breadth of the problem and of its character.

The Traffic Problem.—In the first place I would like to outline to you just a little bit what the traffic problem is, because while you are in the midst of it constantly it is very difficult to vizualize its influence on social life unless you have really studied it. The problem of traffic as illustrated in the streets and highways of American cities is the problem of unbalanced supply and demand, or of too great pressure in a carrying system which we have at present. We must operate arteries of travel over the street and highway systems which we have, and this is a problem, particularly in the case of such highways as have expanded very rapidly during the last few years, but which are connected with streets where the expansion has been slow.

The street system in the central part of Boston is practically identical with that laid down 100 years ago; in many parts with that of 150 or 200 years ago. It was originally designed for the needs and requirements of community necessities for travel of a small colony, using a very different type of transportation than we find it necessary to use today. We have built up on that very inadequate street system a tremendous metropolitan system, similar in size to many large cities throughout the country, and then we attempt to pour through it hundreds of thousands of people where only ten or a score or so were intended to move in the first place, and also to move them by very special type of transportation.

Problem Not New.—This is not a particularly new problem in American cities or in the city of Boston. I suppose one of the most acute traffic situations in this city was in the 90's, when traction lines were operating on Tremont and Washington Sts. As some one very aptly wrote, "We have changed the quiet streets of the city of Boston into a situation of chaos where quiet streets no longer prevail and where electric monsters crush out human lives . . .," etc. Those electric monsters have disappeared underground, which has been a temporary traffic salvation, but in the past quarter of a century the old methods of travel, particularly by means of mass transportation, have changed. We have added a torrential flood of motor vehicles.

I know of nothing so striking in the change of physical habits as the manner in which the American people have adopted, absorbed and utilized motor power. We are accustomed to hearing this past quarter of a century referred to as the age of the development of flight. We might with equal reason refer to it as the age of development in the use of the motor vehicle. It was only a quarter of a century ago that it came to stay. In that short period of time not only has the motor car developed to the efficiency of the greatest mechanical refinement, but it has been so rapidly reduced as to price of production that practically every one can own one. Almost every student of mine has at least a Ford, and I know that out in Los Angeles at least, Fords can be picked up for $25, for $15, and cars that will run, all the way down to $5. Every citizen can own a car, and they do in increasing numbers.

This last year in the United States showed a registration of about 24,000,000 automobiles—twenty-three and a half million, to be exact. Thirty years ago there were none. There are only 29,000,000 cars in use in the entire world. We have approximately 24,000,000 of them in the United States. This has changed all the transportation systems and has brought with it a problem of a very weighty character. I should like to indicate very briefly some complexities of the traffic problem as found in the typical American city.

In the first place there is the definitely social problem of automobile accidents. There were killed in the United States last year, in automobile accidents, 27,000 persons, and about 700,500 persons suffered serious personal injuries in automobile accidents. This is in excess of 1½ per cent of the entire population, to say nothing of the tremendous capital and financial loss sustained through automobile accidents. The social problem is, therefore, one of the greatest importance, and a very definite problem in connection with traffic control throughout the country. It is being met by various agencies, but unfortunately few seem to be able to make much impression on this particular part of the problem.

Economic Factor of Traffic Problem.—The second part is the economic factor, and this also is a very serious one. The cost of living and the cost of commodities depend to a very great extent upon local transportation charges. The cost of trucking within cities may amount to as much as 150 per cent of the total external transportation charges. It may cost one and one-half times as much to bring the product to the ultimate consumer as it does to bring it from its place of production to the city. Transportation has also an effect on the location of mercantile concerns. This matter of location is dependent to a very large degree on traffic congestion. It causes what we call the decentralization phenomenon, or the tendency for business to move outward. People in Boston have seen the very rapid and spectacular growth of the Park Square district, for instance. Only a few years ago there were very small and unimportant buildings located there. Today it has become an important retail center, with large buildings. This is an evidence of the tendency of business to grow outward whenever the accessibility of the location is hampered in any way. Every merchant appreciates the importance of accessibility to his business. If his store is inaccessible or traffic congests in front of his door, his accessibility results in loss of sales. People who cannot reach him will seek other markets. It is that tendency which induced Sears Roebuck to build out in the Fenway.

These are some of the aspects of this problem; some of the reasons why the agencies in American cities, interested in business, have bestirred themselves

to take very definite and direct means of dealing with the problem of traffic accidents and traffic congestion.

Planning and Traffic Relief.—I should like to tell you something about the development of the technique for handling this situation and of some of the relief measures that are being used by American cities at the present time. I want to speak first briefly about city planning and regional planning in relation to traffic relief. The traffic problem is largely the problem of too great pressure; too great demand for existing facilities, therefore since the street and highway systems are inadequate the natural relief would seem to be to build additional facilities. That is a perfectly logical answer. It is limited, however, by how far a city is justified in going in spending the necessary money. Boston, for instance, has been hesitant to build the proposed so-called "intermediate highway" for passing travel around the central and southern part of the city to the North Station area. Obviously the cities are not at an end of their traffic problems. What we see today is the indication of even greater problems to come tomorrow. For the motor car, both as the carrier of people and for trucking is so useful it is evident that its use will grow. So therefore any city which fails to grasp the opportunity for traffic relief by establishing better facilities widening the existing arteries, extending its arteries, extending new streets, through construction of traffic relief measures such as the East Boston Tunnel, is, of course, missing an opportunity which, though very costly, might easily be paid for out of the losses which accrue each year. It is difficult to give an exact figure of the losses resulting from traffic congestion. I was talking with the president of the Yellow Cab Company in Chicago a year or so ago, and he said: "Don't you think too much money is being spent on traffic relief?" I said that depended on whether it was wasting as much as the money expended in relieving the situation. He said that seemed to him doubtful. I asked: "How many trips do your cabs make into the loop district?" He told me. I said: "Suppose each cab saves a minute or suppose it loses a minute; how much time would that aggregate?" So he figured out the total number of minutes involved in the operation of his 3,800 cabs, and the number of trips. I said: "How much gasoline do they use when idle?" He figured this out, and it came to 1 gal. every 40 minutes, and at the wholesale rate he was then paying we found that one minute's delay on the 3,800 cabs making trips into the center of the city had a value of something over $100,000 in one year. That indicates how much money may be involved. In Boston one could figure up a tremendous loss which any statistician would recognize as perfectly logical to be laid to the traffic problem. So a great expenditure of money may readily be justified to bring even normal or local relief.

New Principle of Street Construction.—I am not going to talk about the proposed city planning projects of Boston. I do want to emphasize, however, one particular type of relief and particular principle of plan which seem to me most critical and important at the present time in the congested portions of our cities. You realize that so long as we have the operation of vehicles on conflicting routes on the same grade we will not get great speed. If you take Commonwealth Avenue and even widen it to twice its present width Massachusetts Avenue and other crossings, such as at Cottage Farm Bridge, will always seriously limit the activity of the arterial passes to 50 or to 30 per cent of its possible capacity. If you assume two highways meeting at grade, each one with a demand for its full capacity, and then conceive of the traffic control devices necessary to take care of alternating it fifty-fifty for each road, you will see that under the most efficient conditions the capacity of each road would be reduced to 50 per cent. Actually the capacity is reduced to 35 or 30 per cent, because in starting and stopping there is additional lost motion and lost time. It becomes quite apparent in the more congested cities, such as Boston, Chicago, New York, Philadelphia and Detroit, that we must turn to a new principle of plan in street construction if we are to use the automobile to its full capacity and speed up traffic conditions.

Development of Superhighways.—Whenever a city has reached a population of approximately 1,000,000 it has been found necessary to take the traction facilities and develop rapid transit by elevated structures or by subways. You can no longer operate on the surface because of interference. The same thing is apparent in the case of the major truck lines, and rapid transit highways are being developed with grade separation so that at no point will there be the necessity of limiting the capacity of the routes through interference of cross traffic. We would have thought that idea very futuristic only a few years ago. Now we have come to regard it as inevitable. You may be interested to know that already it has passed the phase of the theoretical. It is actually being applied. Manhattan has just made an appropriation for the construction of an elevated highway along the Hudson River, with the ultimate plan of extending it all the way to Riverside Drive. Chicago has two examples of the superhighways. It is the only city I know of where one can approach within half or quarter of a mile of the business district at an average speed of forty miles an hour. This is by outer drives along Lake Michigan. They have been constructed with grade separation, without interference of any kind. So you can come into the city at forty miles an hour without the necessity of delay because of traffic control. I think that the planning feature of the future American city, so far as the trunk lines are concerned, will be the construction of elevated streets carrying traffic without grade interference and with country highway speeds. The Bureau is now conducting a study of about half Chicago's area—the Cook County area—to find out if the elevated highways going to the north and northwest would be justified. We are going about it as an engineer would go about the location of a new bridge. We are trying to find the most strategic place to locate it, etc.

But I do want to get to my particular phase of the traffic problem—the part in which the Erskine Bureau is especially interested. About seven years ago a far-sighted student of public administration saw in the city streets a problem of great importance in the future. Seven years are not a very long time, and yet when I undertook for Professor Monro research for traffic conditions, I was able to find only two articles worthy of being catalogued as serious studies of managing traffic in city streets. Today it is difficult to pick up any technical magazine without discovering something on traffic. In that short time it has come to be a very pressing and critical public problem. When we started to study it we found in American cities a situation more or less to be expected. It was a new problem and its seriousness and future importance had not been realized. It was being dealt with as a purely political problem. Officers were assigned, right and left turns prohibited, etc. The American city ordinances were a great hodge-podge of political and city regulations, as you can imagine.

Traffic Control an Engineering Problem.—The first thing we discovered was that it was not a problem to be dealt with by the agencies attempting to handle it. It was an engineering problem, capable of being studied and analyzed and solved and regulated like any other important engineering problem. So we started on that basis and attempted to erect very primitive standards and records which would justify our presenting to American cities a claim that they should establish technical agencies to deal with this problem, then of importance and which would be of much greater importance in the future. This study has now developed into a substantial system, and many American cities have begun to study traffic problems as serious engineering problems. In the last three years there have been established in fourteen American cities traffic engineering divisions. They have established agencies for studying accidents, the causes of accidents, the physical factors involved, congestion conditions, and also are following up the limitations now applied to see whether they bring the required results. Fourteen American cities have such agencies functioning in them, rendering service

similar to that given by the water engineers in connection with the water supply, and the planning engineers in connection with city planning.

A Significant Development in Traffic Engineering.—The most significant development in traffic engineering that has taken place in any American city has recently taken place under Mr. William Williams of the Department of Public Works of Massachusetts, in the creation of the Traffic Engineering Division in the commonwealth. The act of the legislature empowering the Department of Public Works to assume very wide control and jurisdiction over traffic affairs of the entire commonwealth is of significance. This is the first time that an American commonwealth has recognized officially, through its legislature, that the problem of traffic control and vehicular control by statutes and controlling devices is one that takes serious engineering attention, and is a problem to be determined and worked out on the basis of engineering ability and knowledge. It is largely through Commissioner Williams that this act was passed, and his sympathy and earnest endeavor have furthered progress in the solution of the problem in Massachusetts.

More and more city planning agencies are coming to rely upon this technique which is being developed in determining the method in which facilities should be used. Sometimes the most elaborate facilities are not warranted in order to take care of it. I have in mind the Wacker Drive situation. The construction of this drive cost $22,000,000. We watched the construction with considerable interest, and noted two or three places where the combined congestion of traffic was too great. It was designed for horse-driven vehicles. Though it was built with a double deck and wide, it does not work at all. Traffic control devices were installed and rendered it highly efficient, with the exception of two or three portions which will have to be entirely reconstructed.

The Opportunities in Traffic Engineering.—This, in brief, is the development of traffic engineering. It does present in a rather tentative and embryonic form the new opportunity for engineering skill and science offered by this traffic problem. We are depending largely on the young engineers to develop new things, and they are developing them. This is illustrated by the construction and operation of automatic traffic signals. Five years ago there were no automatic system. Today we have the choice of half a dozen signals. The city of Boston will introduce a very comprehensive system of co-ordinate signals in the near future. Only 14 cities employ traffic officers for control purposes. It will not be more than a decade, I believe, before every city of 25,000 or over will have a traffic engineer and every state highway department will be similarly equipped. And to a similar degree in the operation of large fleets of trucks there will be at their heads those capable of ordering traffic operation. This offers an opportunity to the young engineer in a new field.

Acknowledgment.—The foregoing is a paper presented Dec. 19 before the Boston Society of Civil Engineers.

"Insulated Areas" for Relieving Dangerous Traffic Conditions

An interesting arrangement for relieving dangerous traffic conditions was mentioned by E. W. James, Chief, Division of Design, U. S. Bureau of Public Roads, in a discussion on traffic control at the 1929 annual convention of the American Society of Civil Engineers. The scheme consisted essentially of an arrangement of streets within, say an area of a square mile, whereby there would be no incentive to through traffic, although there would be every means for interior communication. Only four means of exit and entrance would be available, and the streets themselves could be of narrow width, since they would handle only local traffic.

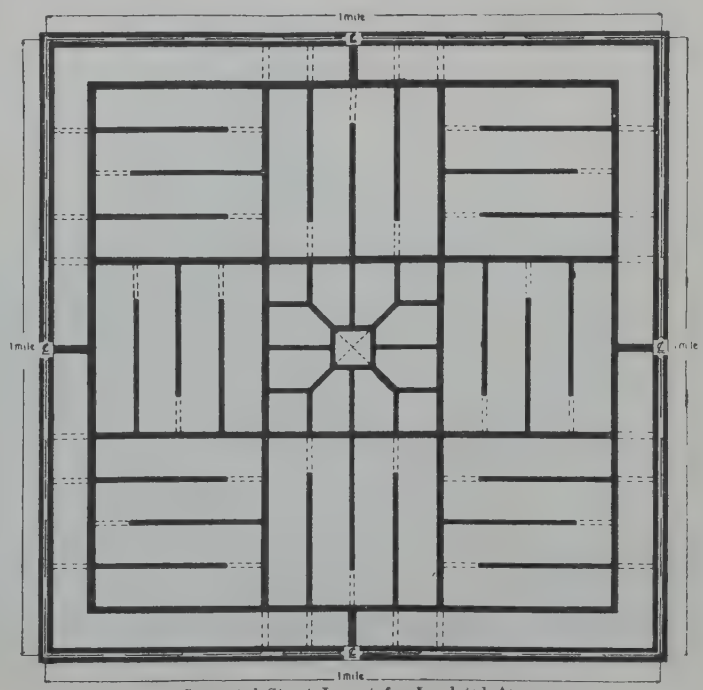
If necessary, the subdivision of such an area could be made to provide (as shown on the accompanying plan) for future extensions of through routes by cutting streets through present parks and by now providing wide rights of way for further enlargement of pavements. Mr. James estimated for such a subdivision that with "eight householders to the acre, all the traffic could leave the area on its way to work within an hour without street congestion at the exits." The interruptions by means of parks would not deter foot traffic, which could use the parkways to be provided. Such a sub-development is Radburn, near Paterson, N. J. Although the partly insulated area is only one-eighth of a square mile, it would have just about the density of population mentioned.

One particularly good feature of the idea, according to Mr. James, is its flexibility:

"Future street systems can be determined in the original layout, if it appears that the locality is likely to change usage and by a proper distribution of parks this system can be broken up and interrupted as desired so long as the area remains residential and insulated. Whenever the area is reclassified, the streets can be made continuous at no additional cost to the community for rights of way by destroying a part of the parks."

Government Statistics of the Cement Industry for February

The ratio of the operations to the capacity of the American portland cement industry during the month of February was 44.8 per cent, according to figures released March 13 by the Bureau of Mines of the Department of Commerce. During the month 8,522,000 bbl. were produced, 5,448,000 bbl. were shipped, and there were in stocks on hand at the end of the month 29,871,000 bbl. Production in February, 1929, was 3.1 per cent less, and shipments 17.0 per cent less than in February, 1928. Stocks at the mills were 9.2 per cent higher than a year ago.



Suggested Street Layout for Insulated Area

Flexible Bases for Vitrified Brick Pavements

Experiences in Mercer County, New Jersey

By HARRY F. HARRIS
County Engineer, Trenton, N. J.

SEVEN years ago the writer constructed a bituminous foundation for a short piece of brick paving. Very frankly, it was an experiment, and he could find little, if any, information to guide him in preparing his specifications as to previous practice, although it was likely that construction of this type had been attempted before.

This short paper will, therefore, be devoted to a description of the work just referred to, and a subsequent job carried out two years later, the details of which were somewhat different as to the method of constructing the base. In the first work a penetration type base was used, wherein tar was employed as a binding medium, but in the latter case the foundation was of the hot mix type of bituminous concrete. In this, asphaltic cement was utilized, to bind the mineral aggregate together, instead of tar. The first highway to be improved was located near the city of Trenton.

View of East Clinton Ave., Showing 5 Per Cent Grade, Paved with 3-in. Vertical Fibre Bricks, with Asphalt Film on Penetration Macadam Base

Conditions on East Clinton Ave. Job.—On both sides of the street, known as East Clinton Ave., there was located a large industrial plant which had buildings lining both sides of the thoroughfare. It was essential to keep the roadway, during the paving operation, in such condition that trucking and other vehicles would have access to the plant constantly, because large quantities of this company's product were shipped by trucks daily to a freight station, located about ½ mile distant.

Under standard methods, to improve the street for the character of traffic required, it would have been necessary to shut traffic off entirely while building the street, or construct the pavement and foundation under the half-width method, both of which methods were very undesirable, and would entail great losses to this large company, as it had no other means of access to and from the plant.

Preparation of Sub-base.—After giving some thought to the situation, it was decided that the use of a black base would solve our difficulties. As part of the street in question had a maximum grade of 5 per cent, it was decided to pave this section with 3-in. vertical fibre brick, using a bituminous filler. The old roadway was metalled with 4 to 6 in. of broken stone, about 20 ft. in width, and beneath this, for the most part, was a sandy subgrade. At the foot of the 5-per cent grade, the ground water level very nearly coincided with the proposed grade fixed for the bottom of the sub-base, and it was difficult to lower this by means of drains, except at certain seasons, because its height was controlled by the stage of a creek of considerable size, ¼ mile distant, and the material below the sub-base was filled with quick sand. The question of saturation of the subgrade and the material beneath presented some little problem. This low point in the grade was created in order to provide adequate headroom beneath the main line tracks of the Pennsylvania R. R., and the surface water from this sump was carried away by a pipe line laid at a gradient of approximately 0.001 per foot. To meet this situation,

View of Whitehead Road Near Trenton, N. J., Showing Industrial Buildings; 5 Per Cent Grade Paved with 3-in. Vertical Fibre Brick on 6-in. Bituminous Concrete Foundation

Sand Cushion Spread Ready for 3-in. Vertical Fibre Brick

a system of French drains was designed and these drains were tapped into the storm drain at close intervals, which plan, it was felt, would at least keep the base free of ground water when the stage of the creek was such as to permit the water to flow from the intake to outlet of the drain.

Our next problem was to obtain a binding medium for the penetration macadam base which would not disintegrate under the moisture to which this foundation might be subjected at certain times. After giving some thought to it, we arrived at the conclusion that tar would probably answer. Before laying our base, however, we decided to use the old macadam from the roadway as a sub-base. The subgrade was found to be very dry and sandy, as soon as we got away from the sump beneath the railroad, previously referred to. This sandy subgrade was difficult to shape and could not be rolled, so the stone sub-base, laid 4 in. thick, worked to very good advantage, because it not only reinforced our black base by adding additional depth, but it enabled the contractor to shape and roll his subgrade exactly to the contour desired for the base stone.

Construction Methods.—The foundation proper was built in two layers. The first was built 3½ in. deep, after compression, and of 2½-in. trap rock. To this was applied the hot tar by a pressure distributor, at a rate varying between 1.25 to 1.5 gal. per square yard. This was chipped with ¾-in. stone and rolled, after which the second course of trap rock, 2½ in. deep, was applied, making a total depth over all of base of 6 in. The latter course was composed of the next smaller size of stone, known as 1½-in. trap rock. This was penetrated with tar at the rate of 1¼ gal. per square yard, and chipped with ¾-in. stone to close up the voids and to facilitate the rolling. In other words, the base was composed of a penetration macadam pavement built close to accepted standard methods, except that a seal coat was omitted. Following the completion of the foundation, the remainder of the pavement was constructed as most other brick pavements are built. A sand cushion was applied to the foundation, and varied from ½ in. to 1½ in. in depth. After this was properly shaped, the bricks were laid with joints filled with asphalt filler. The contract price for the job complete was $5.39 per sq. yd., which was 11 per cent less than the engineer's estimate, and was divided as follows:

	Per Sq.Yd.
Excavation (Av. depth 1.1 ft.)	$0.49
3-in. Sub Foundation	.18
6-in. Penetration Macadam Foundation	2.05
3-in. Vertical Fibre Brick Surface	2.67
Total	$5.39

A traffic count taken over this road in 1924 showed an average daily traffic of 2,319 vehicles for a 16-hour day. In 1925 this had increased to 2,688, which is the last count taken, and it is quite probable that the present traffic exceeds 3,000 vehicles per day, a comparatively large part of which is composed of commercial cars.

During the building of this street, traffic was maintained throughout every working day, although there were certain periods during some of the days, where the manufacturer had to delay his hauling a matter of a few hours, which is almost negligible, when compared to what the delays and loss would have been, had some other method of construction been selected.

The Whitehead Road Improvement.—Two years later the engineering department of the county was faced with a similar condition in a nearby district. This highway, known as Whitehead Road, also passed through an industrial section, where no detours were available, and it was necessary to maintain traffic. As the experiment had worked out rather satisfactorily in the previous case, it was decided to resort to much the same methods as used before. The drainage conditions were better, however, and it was believed that if a hot mix asphalt was used for the base, instead of a penetration macadam, it could be laid quicker and to a truer surface, as some little difficulty was experienced in the former job in getting a true contour. The foundation was laid in two 3-in courses, each of which was rolled and compacted in the usual way of laying ordinary bituminous concrete pavement. It was specified that the weight should not be less than 600 lb. per square yard of completed base. When completed, it was found that it had been laid at the rate of 655 lb. The stone composing this base was of somewhat smaller size than the original job.

The Black Base.—A typical analysis of the black base mixture follows:

Screens and Sieves—Passing	Retained On	Percentage
1½ in.	1 in.	20.8
1 in.	½ in.	45.0
½ in.	¼ in.	8.0
¼ in.	10 Mesh	2.6
Stone		76.4

Laying Brick on Whitehead Road, Mercer County, New Jersey

10 Mesh	30 Mesh	4.0
30 Mesh	50 Mesh	4.2
50 Mesh	80 Mesh	4.6
80 Mesh	200 Mesh	4.4
200 Mesh		1.6
	Sand	18.8
Bitumen Content		4.8
	Total	100.0

This mixture was manufactured in a regular asphalt paving plant, located about a mile away and hauled to the job. The asphalt cement used had a penetration of between 40 and 45. It was found that the hot mixed pavement rolled to much better advantage than the penetration foundation, and it was laid for 5 ct. less per square yard than the penetration foundation, but for some unknown reason the price of brick surface was increased over the price obtained two years previous by 68 ct. per square yard. It may be, however, that the first contractor lost money on his brick surface.

Spreading Sand Cushion Over Flexible Base on Whitehead Road

Costs.—The total cost of the second job was $5.82 per sq. yd., or 7 per cent in excess of the engineer's estimate, and 43 ct. over the price obtained two years before. This price was divided as follows, on a square yard basis:

	Per Sq.Yd.
Excavation (Av. depth of 7 in.)	$0.20
4-in. Stone Sub Foundation	.27
6-in. Bituminous Concrete Foundation	2.00
3-in. Vertical Fibre Brick Surface	3.35
Total	$5.82

It should be remarked that these jobs have required no maintenance expenditures whatever, except for the repairing of a slight settlement which occured over one of the French drains in the first described job.

As a result of the experience of these two contracts, a total of 40,000 additional yards of pavement with black base was subsequently utilized, using other types of surfacing, and as an expedient for meeting difficult traffic situations with a minimum of delay in construction, it is believed that the use of black base is a big step in solving this difficulty.

In conclusion, the writer wishes to make it clear that he does not claim that the form of construction described offers a panacea for all our difficulties encountered in road design and construction, but like many other problems which all engineers meet in their practice, the remedy selected for a given ill must be adaptable to the peculiarities of the case in question, after all the factors concerned have been given proper consideration.

Acknowledgment.—The foregoing is an abstract of a paper presented Feb. 15 at the 23rd annual meeting of the National Paving Brick Manufacturers' Association.

Cleaning Well Screen with Steam

Various well water supplies in Maryland have on different occasions experienced trouble with the clogging of well screens. A study was made by the Bureau of Sanitary Engineering of the Maryland State Department on the well screens from Princess Anne to find a satisfactory method for cleaning. The results are summarized as follows in the 1928 report of Abel Wolman, Chief Engineer of the bureau:

The deposits on the inside of the screens consisted principally of iron oxide and had accumulated to such an extent as to coat almost completely over the openings, thus preventing any water from passing through the brass mesh. An attempt was made to clean the screens with (1) dilute hydrochloric acid; (2) dilute nitric acid; (3) compressed air (100 lb. per sq. in.), and (4) steam (140 lb. per sq. in.).

Both hydrochloric and nitric acid removed the deposits fairly readily, but the acids attacked the screens to such an extent that the metal was destroyed rapidly. The deposits when dry were removed rapidly and completely from the screen by compressed air, but the process is very dusty and would be inconvenient in practice. In addition, high pressure air is not available at most plants.

Steam readily cleaned the deposited iron oxide from metal and is not objectionable from the standpoint of dust formation. An inspection of the screens after steaming showed that the process was effective and almost completely removed the deposits. The method of operation consisted merely in discharging the steam through a ½-in. jet against the outside wall of the screen and then passing water through the screen to wash out of the small amount of oxide that has not been blown from the inside of the screen tube. A single screen section could be cleaned by this method in five minutes, and with a steam supply available, the cost of treatment is practically negligible.

Whitehead Road Flexible Base Ready for Sand Cushion

The Dunbar Sewage Filter Bed

Investigations at Texas Engineering Experiment Station

THE Dunbar sewage filter bed was developed in Germany by Dr. Dunbar, who built a number of installations at Hamburg and elsewhere which apparently did good work. Several beds following the Dunbar model were built in Texas during the past ten years. Inspections of the Texas plants usually revealed that, even with all the vicissitudes of operation which the small city plant must usually withstand, the effluent was fairly clear and inodorous, caused no unpleasant conditions in streams and the plants, in general, were free from nuisances. The plants, from this standpoint, appeared to have some advantage over the ordinary trickling filter.

Examination of sewage treatment literature discloses the fact that little or no study has been made of the Dunbar bed, as to its effectiveness in treating sewage, its method of operation, or its particular field of application. Accordingly, an experimental filter bed was constructed at the A. and M. College of Texas and tests of the effluent, under varying conditions of operation, were made by the Sewage Research Division of the Texas Engineering Experiment Station. The results of the investigation have been given in a bulletin issued recently by the Texas engineering experiment station, of which F. E. Giescke is director. The bulletin was writen by E. W. Steel and P. J. A. Zeller, and from it the matter in this article has been taken.

Construction of Experimental Bed.—The details of construction of the experimental bed are shown in Fig. 1. They follow, in the main, those developed by Dr. Dunbar. A 16-in. layer of comparatively fine material was supported by several layers of graded aggregate and the whole rested upon a layer of rather large material.

Sizes and thicknesses of layers beginning at the top were as follows:

16 in. layer	1/25	in. to	⅛ in.
4 in. layer	⅛	in. to	⅜ in.
4 in. layer	⅜	in. to	1½ in.
24 in. layer	3	in. to	6 in.

The bed was 4 ft. wide, 6 ft. long, and 4 ft. deep. The bottom and sides of the filter bed were constructed of wood with holes bored in the sides near the bottom, so that air might enter the lowest layer of filtering material. The bottom of the box was lined with sheet metal. An opening with a small trough at one end drained the bed, and allowed collection of samples.

In order to obtain variable rates of application of sewage to the bed, an orifice in a metal tank was used. The head on the orifice was varied by regulating the height of an overflow pipe

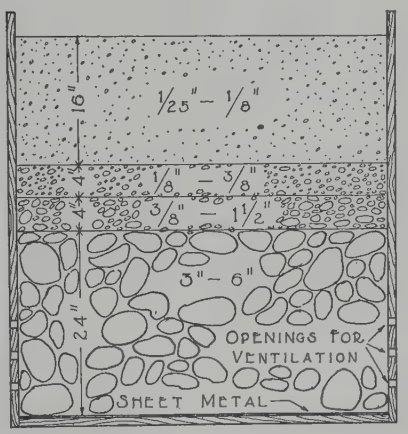


Fig. 1—Cross Section of Experimental Dunbar Filter Bed

which discharged excess sewage from the dosing tank. The orifice discharged upon a flat tile to prevent scouring the surface of the bed. The bed was located at the east side disposal plant of the A. & M. College and so placed that it received, by gravity, sewage settled in an Imhoff tank. Except for occasional clogging of the orifice during the first few runs of the bed, no difficulty was experienced in obtaining the rates desired.

Operation of Experimental Bed.—Dunbar beds are dosed by means of a trough running down the middle of the bed. The sewage leaves the trough through holes or by overflow, and percolates into the filtering material. The dosing continues until the surface of the bed is clogged, which is indicated by the sewage standing several inches deep over the bed. The bed is then thrown out of operation for rest and for cleaning of the surface.

The procedure just described was followed in the experimental work. The sewage was applied to one end of the bed directly from the orifice and allowed to spread over the surface until clogging caused the sewage to stand at a depth of 3 to 4 in.

Since the purpose of the study was to determine the efficiency of the Dunbar bed under various dosages, and to discover the most favorable rate of dosage, the experimental bed was operated at widely varying rates. Tests were made of the applied sewage and the effluent to determine the effects of varying conditions upon the bio-chemical oxygen demand, suspended matter, dissolved oxygen, free ammonia, nitrites, and nitrates. The tests extended over a period of one year, during which time the bed was operated as nearly continuously as the necessary resting and drying periods permitted. The sewage treated was stronger than the average domestic sewage which has been settled in Imhoff tanks.

Findings.—As might be expected, the quality of the effluent varied with the rate of dosing and to a lesser extent with the character of the applied sewage. Aside from these factors, no other conditions appeared to have any appreciable effect. Temperature conditions are favorable in this section of Texas and the few periods of low temperature made no apparent difference in the action of the bed. There was no pronounced falling off in the quality of the effluent during the progress of a run. That is, the bed worked as effectively after operating three or four days as it did immediately after resting.

During the investigation it soon became apparent that the practical rates of application lay between 1,000,000 and 2,000,000 gal. per acre per day. It finally appeared that 1,300,000 gal. was most suitable.

Bio-Chemical Oxygen Demand.—These determinations were made by the dilution method, using Mohlman's diluting water (i. e., distilled water containing 500 ppm. of sodium bicarbonate), and incubating for 5 days at 20 degrees Centigrade. Theriault's differential method of calculation was used in arriving at the demand.

The reduction in the oxygen demand was uniformly good, averaging 85 per cent. A very few tests showed 75 per cent, while others indicated over 90 per cent reduction. The reduction was practically independent of the rate of dosage and of the strength of the applied sewage.

The applied sewage varied from below 100 ppm. to as high as 400 ppm. in bio-chemical oxygen demand. The

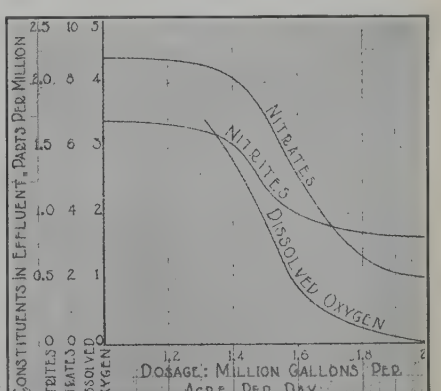


Fig. 2—Curves Showing Relation Between Rate of Dosing and Nitrites, Nitrates, and Dissolved Oxygen

Table I—Data Obtained in Three Typical Runs of the Bed

No. of run	Rate Million gals. per acre per day	Days	INFLUENT Solids ppm Total	Suspended	B O D ppm	Ammonia ppm	Nitrates ppm	EFFLUENT Solids ppm Total	Suspended	Dissolved oxygen, ppm	B O D ppm	Ammonia, ppm	Nitrites ppm	Nitrates ppm	CHANGE B O D Reduction percent	Suspended Solids Reduction percent	Ammonia Reduction percent	Nitrite Increase ppm	Nitrate Increase ppm
20	1.32	0	2060	52	145	22	0.24	2100	6.6	4.2	16	1.8	5.6	9.0	89.0	87.3	91.8	5.6	8.8
		1		44	107	17	0.40		6.8	4.4	11	2.0	1.2	3.0	89.5	84.6	88.2	1.2	2.6
		2	2010	41	116	12	0.00	1910	8.4	4.0	10	1.0	1.5	8.0	91.2	79 3	91.7	1.5	8.0
		4	1773	25	95	18	0.60	1720	6.8	2.9	12	3.8		4.4	87.5	72.8	79.2		3.8
		5	1855	28	88	18	0.95	1800	6.2	3.3	16	1.0		3.2	81.7	77.9	94.9		2.2
		Average	1924	38	111	17	0.44	1882	6.96	3.76	13	1.9	2.8	5.52	88.0	81.6	89.0	2.77	5.08
21	1.64	1	2180	90	219	26	0.48	1750	47	1.9	25	3.6	1.5	3.0	88.5	52.2	86.2	1.5	2.5
		2	2670	58	95	23	0.16	2030		0.7	26	1.6	.45	1.4	72.8		93.6	.45	1.2
		3	1990		185	18	0.16	2315	89	0.2	31	1.4	.45	0.4	83.5		92.2	.45	0.24
		4	2135	92	252	36	0.56	1865	89	0.1	46	1.6	.30	0.5	81.8	57.3	95.5	.30	—.04
		Average	2244	83	188	26	0.34	1990	41.7	0.73	32	2.0	.68	1.33	83.0	49.8	92.1	.68	0.99
24	1.97	0	2095	15	221	11	0.6	2710	18	0	37	1.6	1.5	2.2	83.3	+12.4	88.6	1.5	1.6
		1	1880	61	177	22	0.2	2005	14	0	15	1.0	1.5	4.8	91.7	77.7	95.4	1.5	4.6
		2	1815	93	226	18	0.16	2665	20	0	28	1.0	.75	0.7	87.6	78.5	93.7	0.75	0.54
		3	2125	97	147	22	0.0	2780	22	0	33	1.4	1.4	1.2	77.7	77.1	93.6	1.4	1.2
		4	2090	108	217	22	0.0	1750	21	0	25	2.0		1.4	88.7	78.2	90.9		1.4
		5		25	102				10	0	21				79.4				
		Average	2007	66.5	182	19	0.19	2382	17.5	0	26	1.4	1.29	2.1	85.5	73.7	92.7	1.29	1.91

amount of actual reduction varied, but the percentage reduction was practically constant. Doubling the rate of application of the sewage to the bed, that is, from 1,000,000 to 2,000,000 gal. per acre per day, produced only minor fluctuations in the percentage reduction.

The relative stability of the effluent was not determined as a routine test. A number of tests were made, however, and in nearly all cases complete stability was obtained.

The ability to reduce the oxygen demand to such a high degree under varying circumstances is an important quality of the bed as it insures good treatment of the sewage, even though the bed be overloaded, poorly operated, or the settling tanks operated inefficiently.

Nitrogen.—The reduction of free ammonia was uniformly high. Here, also, the quality of the applied sewage had no appreciable effect. High rates of application, also, lessened the percentage reduction only slightly.

Varying the rate of application had its principal effect upon the production of nitrites and nitrates. Variation in the quality of the effluent with the rate of dosage is shown in Fig. 2. For example, for a rate of 1,000,000 gal. per acre per day the effluent contained 10 ppm. nitrates, 2 ppm. nitrites, and 4 ppm. dissolved oxygen. Increasing the rate of dosage caused a decrease in all three quantities, gradually at first, but quite rapidly at 1.6 millions. Table I shows some of the data from which Fig. 2 was constructed. As might be supposed, the high rates interfered with complete nitrification. With favorable rates of application, however, an ammonia reduction of 90 per cent may be expected, with nitrites in the effluent amounting to 2 to 3 ppm., and nitrates from 5 to 10 ppm. High rates of dosage caused a very considerable drop in the nitrates with a tendency for them to hover around 1 to 2 ppm., and with the nitrites somewhat less in amount.

With the ammonia reduction remaining practically constant with varying rates of dosage, and with the nitrates and nitrites considerably less with high rates of dosage, the question arises as to the cause of the discrepancy between the ammonia nitrogen and the total of the nitrite and nitrate nitrogen. Even with the lower rates of dosage, similar discrepancies occurred, the ammonia reduction indicating a higher nitrification than was actually taking place. There may be several explanations. The nitrogen may combine with organic matter. Or, especially with the high rates of filtration, denitrification may be taking place through the agency of denitrifying bacteria. The services of a bacteriologist were not available to investigate the cause of the variations.

Dissolved Oxygen.—Fish require dissolved oxygen. The maintenance of fish life near a disposal plant outlet materially reduces mosquito nuisances. Accomplishing this has been particularly difficult in Texas, where many of the streams receiving plant effluents furnish no diluting water during the summer months. Consequently, dissolved oxygen determinations were made to discover the maximum rate of dosage at which dissolved oxygen might be expected in the effluent. Effluents containing dissolved oxygen in appreciable amounts will probably be well nitrified and stable.

With a rate of more than 1,600,000 gal. per acre per day no dissolved oxygen appeared in the effluent at any time. (See Fig. 2.) As the rate was decreased the dissolved oxygen rose rapidly, reaching 4.0 ppm. in many samples when the rate of dosage was 1,000,000 gal. per acre per day. Operating at the rate of 1,300,000 gal. per acre per day should assure enough oxygen to support the top-water minnow. Fluctuations in strength of the influent, as measured by the bio-chemical oxygen demand, showed no appreciable difference in the dissolved oxygen content of the effluent.

Suspended Matter.—Removal of suspended solids showed considerable variation under different conditions. Percentage removals tended to be greater when the suspended solids in the influent were high. The nature of the suspended matter was an important factor. When it was coarse and flocculent, removal was high; when the solids were colloidal, reduction was smaller. Varying the rate of dosage caused a variation in percentage removal, but its effect was less than that of the variation of the quantity and the condition of the suspended matter. The average removal, arrived at by considering all the runs of the bed, was about 75 per cent. In every case, the effluent from the bed was colorless and clear, in spite of the fact that the color and turbidity of the influent were frequently quite marked.

Dosage.—From the data obtained, it appears that 1,300,000 gal. per acre per day is the optimum rate. Lower rates add little to the quality of the effluent. Higher rates produce an effluent less nitrified and with little or no dissolved oxygen. (See Fig. 2.) From the standpoint of economy, therefore, it would be inadvisable to dose at rates lower than the optimum. Higher rates, however, might be permissible where some diluting water is available at all times in the stream receiving the effluent.

Low and high rates of dosage exert a considerable influence upon the length of runs before cleaning of the filter surface becomes necessary. Length of runs varied not only with the rate of application, but also with the amount and character of the suspended matter in the applied sewage. The actual volume of suspended material removed varied with each run. The conclusion reached was that the quantity of suspended matter and its physical condition have an important bearing upon the operation of the filter bed. Upon an average, the bed handled a total of 8,000,000 gal. per acre before clogging was severe enough to necessitate resting and cleaning.

Length of rest period apparently had but little effect. The rest periods were long enough to allow the surface clogging material to dry. This required less than 36 hours under average conditions, provided there was no rain. prolonging of the rest period beyond the 36 hours had no effect, beneficial or otherwise, upon the effluent produced during the next run. Cleaning of the surface preliminary to resuming operation proved to be necessary. When it was omitted, clogging occurred within 24 hours after the bed had again been placed in operation.

Cleaning Bed Surface.—The solids strained out and retained on the surface of the bed dried, in good weather, within 36 hours. They were then in the form of curled, leathery, black flakes, ¼ in. or less in thickness, more

or less detached from the bed surface, and they could easily be raked or hoed into piles and then removed. The work of cleaning a bed of practical size, say 30 ft. by 70 ft., will consume only an hour or two of an operator's time and will produce only a few wheelbarrow loads of dried solids. There is no appreciable loss of filtering material in removing the solids.

Summary and Conclusions.—The experimental work has established the following outstanding characteristics of the Dunbar filter:

1. At rates of operation up to 2,000,000 gal. per acre per day, an 85 per cent reduction in the bio-chemical oxygen demand may be expected.
2. Operation at the rate of 1,300,000 gal. per acre per day proved to be the optimum rate. It is the highest rate at which the following condition can be secured:
   (a) Good nitrification of the effluent.
   (b) High dissolved oxygen in the effluent.
3. Operation at a rate above the optimum and up to 2,000,000 gal. per acre per day will produce a clear effluent, satisfactory for many purposes, but nitrification will be incomplete and dissolved oxygen will not be present.
4. Clogging of the bed may be expected after the application of 8,000,000 gal. of settled sewage per acre of bed surface.
5. Prolonged resting of the bed between doses is unnecessary, although it apparently does no harm. Resting is necessary only to allow drying and removal of the solids caught upon the surface of the bed.

Chlorination of Deep Well Supply

Elimination of Iron Bacteria from Distribution System

By M. F. TRICE
Assistant Engineer, State Board of Health, Raleigh, N. C.

In the early summer of 1928 a disagreeable taste and odor developed in the Siler City water supply. At that time the municipal water system had been in operation three years. There had been no objection to the city water during the first year, but during the second, in the spring of 1927, a taste and slight odor developed which was easily detected. This condition existed for some two months, disappearing before the end of the summer; the one remedy applied at the time was periodic flushing of the mains. No trouble has been experienced during the winter months. With the advent of spring, however, the taste and odor returned with greater intensity, reaching a maximum last May. The citizens refused to use the city water preferring well and spring supplies. Flushing of mains was resorted to, but with little success. Samples of water sent into the State Laboratory for examination were found to be of satisfactory sanitary quality. This fact was broadcast, but to no avail, and complaints were daily piling into the city clerk's office. This was the status of the problem when an investigation was begun to locate and, if possible, to eliminate the offending taste and odor.

General Features of Water System.—The present municipal supply was constructed and installed during the summer of 1925 and was put into service in September of that year. Briefly the system consists of two deep wells, 365 and 380 ft. deep, respectively. A separate pump serves each and both discharge into a covered concrete reservoir of 200,000 gal. capacity. As an additional reserve a steel elevated tank of 100,000 gal. capacity is available. All equipment, mains, service connections, etc., were new except one pump bought second hand.

The fact that entire system was of new material made pipe growths appear an unlikely hypothesis. Contamination from an open trap door in reservoir or elevated tank or possible diffusion of mill sprinkler water into the city mains received more serious consideration as an explanation. Investigation disclosed that the trap doors to the reservoir and elevated tank, respectively, were always closed.

A textile mill, operating a sprinkler system using city water, was connected through check valves and several other industrial establishments using air filled sprinkler systems were found to maintain a constant air pressure greater than the water pressure. The air systems, too, were connected to the city system through a complicated arrangement of valves. The various mill sprinkler systems have been installed since the town supply was inaugurated, except the textile mill whose sprinkler system antedates the establishment of the town supply. Some doubt existed as to whether or not the latter should be eliminated as the source of trouble. It was eliminated for the time being as were the other industrial establishments and attention directed to the mineral and biological character of the water.

Iron Content of Water.—Ground water supplies of the state differ from the surface supplies in that practically all are hard waters and contain an appreciable and sometimes objectionable quantity of iron. The Siler City water was characteristic of all such supplies, the iron content being noticeable as indicated by housewives complaining of a brown sediment forming in kettles and pots. Field equipment did not contain reagents for an iron determination. Results of a few simple tests are as follows: pH 7.2; hardness (soap method) 81 p.p.m. and alkalinity to methyl orange 103 p.p.m.

It was observed on several occasions that in flushing mains the water flowing for the first few minutes contained a brown sediment. Every water superintendent is familiar with such occurrences and expect such to happen in sections of town where little water is used. It is often the case that water acquires a flat taste and sometimes an odor due to stagnation in a pipe line that serves few houses. This condition is immediately relieved by a thorough flushing of the mains. A great many taste and odor problems are relieved by this simple expedient. At Siler City the taste and odor persisted in spite of thorough and frequent flushings. Evidently then some pipe condition was to blame.

Samples of water from the hydrants containing this brown sediment were therefore examined microscopically for the presence of iron bacteria, as crenothrix was suspected. In several samples examined small thread-like filaments were observed. This seemed to be sufficiently conclusive that iron bacteria existed in the distribution system. As flushing had not removed the taste and odor problem, it was decided to sterilize the mains with chlorine.

Application of Chlorine. — Accordingly, an emergency chlorinator outfit was brought from Raleigh and a tank of chlorine obtained. As a heavy application of chlorine seemed advisable, it was deemed unwise to chlorinate during the day. Therefore, to inconvenience the citizens as little as possible, the chlorination was begun at eleven o'clock at night.

The chlorinator is a dry feed apparatus of the diffuser type. It was attached to the effluent from the reservoir at a point half way between that and the pump to town. With a hydrant open in town, pumping was started with strong chlorine application. A hydrant was allowed to run until a good orthotolidine test was obtained, when another hydrant was opened and the process repeated. Thus hydrants were flushed in all parts of town until the entire system was saturated with chlorine. This required about five hours, as chlorination was complete at 4:00 a. m. the following morning.

The next day the town office received many complaints, as the chlorine content of the water was sufficient to be objectionable. With the disappearance of the chlorine from the system, the taste and odor situation improved and within a week all trace of it was gone. The superintendent is positive that flushing alone would not have completely remedied the trouble, and provided that it would have been effective, the cost would have been much greater.

This is the first instance of its kind in North Carolina where iron bacteria have been satisfactorily eliminated from a distribution system with chlorine.

Acknowledgment.—The foregoing is a paper presented before the North Carolina Section of the American Water Works Association.

Sewage Treatment Plant Records at Worcester, Mass.

Careful Preparation of Records May Save Expensive Litigation

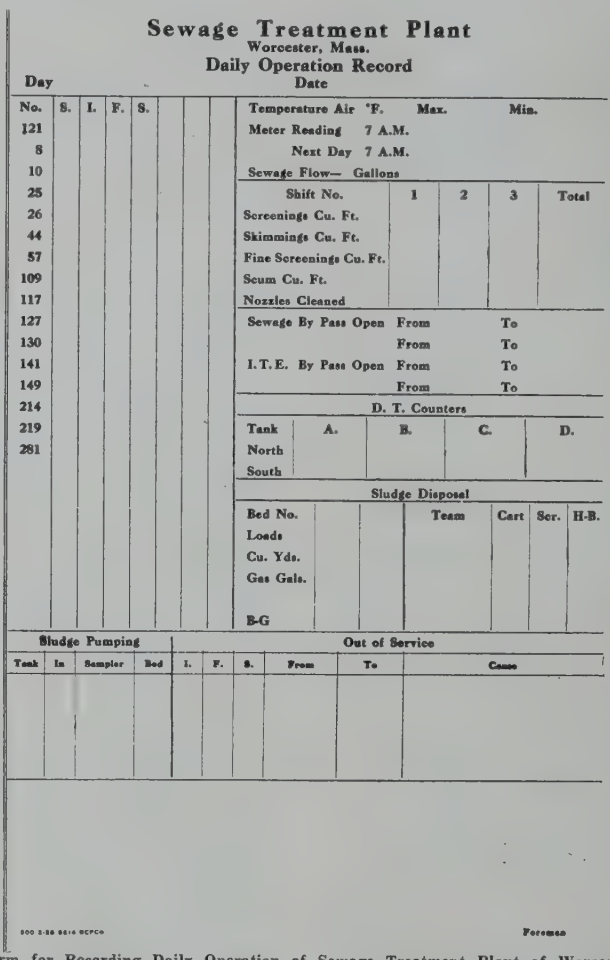
By ROY S. LAMPHEAR
Supervising Chemist, Sewer Department, Worcester, Mass.

SEWAGE treatment was first started in 1890 by the city of Worcester under an act of legislature. During the life of the old plant, the attention of the court was directed from time to time to the condition of the Blackstone River below the discharge of the Worcester plant effluent. No court action proceded very far before it was dropped. Laboratory records maintained in great detail have always been considered an effectual barrier to such court action. The city of Worcester has from time to time carried on a considerable amount of experimental plant operation. For more than 20 years operators have signed tags accompanying daily composite samples and these tags have been carefully filed upon advice of the city solicitor.

The present sewage treatment plant was placed in operation in June, 1925, in accordance with an act of legislature. The state department of public health has certain jurisdiction over the plant in case of inefficient operation. In case of action against the city of Worcester involving the sewage treatment plant, the operating records and the chemical analyses of the plant and river samples furnish the real defense or protection. The writer has perhaps gone further into this matter than seems necessary because he feels that the expenditure of a small sum of money in careful preparation and preservation of records may save expensive litigation, if ever such occasion should arise.

Record of Daily Operation.—A daily operation record form, as shown in Fig. 1, is filled out by the foreman who records all of his observations of unusual conditions in the work done. In a general way, the form is self-explanatory; blank columns are left for additional time charges, the four usual charges having been noted. The dosing tank counter readings are those at 7 a. m. of the next day, so that the Venturi meter and counters can be checked against each other when no sewage or Imhoff tank effluent has been by-passed. The operators use a notebook in which to record the meter and counter readings. When by-passing of sewage or Imhoff tank effluent occurs, the chemist has the data for determination of the quantity by-passed.

The foreman is required to record all routine operations and any measurements relating thereto, such as grit in chambers before and after flushing, depths of sludge and scum in the Imhoff tanks. If the cost of some particular work is desired, the blank time columns are used. The chemist makes any notations desired on these sheets from day to day.



Sewage Treatment Plant
Worcester, Mass.
Daily Operation Record

Day — Date

No.	S.	I.	F.	S.
121				
8				
10				
25				
26				
44				
57				
109				
117				
127				
130				
141				
149				
214				
219				
281				

Temperature Air °F. Max. Min.
Meter Reading 7 A.M.
Next Day 7 A.M.
Sewage Flow— Gallons

Shift No.	1	2	3	Total
Screenings Cu. Ft.				
Skimmings Cu. Ft.				
Fine Screenings Cu. Ft.				
Scum Cu. Ft.				
Nozzles Cleaned				

Sewage By Pass Open From To
From To
I.T.E. By Pass Open From To
From To

D. T. Counters

Tank	A.	B.	C.	D.
North				
South				

Sludge Disposal

Bed No.			Team	Cart	Scr.	H-B.
Loads						
Cu. Yds.						
Gas Gals.						
B-G						

Sludge Pumping				Out of Service					
Tank	In	Sampler	Bed	I.	F.	S.	From	To	Cause

Foreman

Fig. 1—Form for Recording Daily Operation of Sewage Treatment Plant of Worcester, Mass.

These daily operation sheets are held in a loose-leaf cover for periods of four months and then bound in press-board for keeping as original records. Data from them are recorded each day in ink in a daily operation record and a sludge disposal record. Ready reference in detail is quickly available; nothing is entirely dependent upon memory and, in case of necessity, the records and daily operation sheets become valuable evidence in court.

A check upon the time of cleaning the screen is available, as the Venturi meter charts show the increased rate of sewage flow. A Ferguson rain gage and a snow-board furnish the rainfall and snow records. A Bristol recording thermometer registers the temperature of the air throughout the seven days of the week. These charts are carefully filed for reference. Signatures of operators and helpers are required on the same tags, which are carefully preserved by direction of the city solicitor.

Records of River Below Point of

Second Shift 3 P.M. to 11 P.M.

Weather

Operating Notes

Operator

Third Shift 11 P.M. to 7 A.M.

Weather

Operating Notes

Operator

Back of Fig. 1

Effluent Discharge.—Samples of Blackstone River water are collected once a week. The collector signs dated tags and fills out a record of observations, a copy of which is shown in Fig. 2. The tags are filed; the loose-leaf observation records are held in a cover for one year and then bound in press-board covers and properly labeled. The analyses of the river water are recorded on a printed form at the laboratory bench and transferred to the laboratory record. The laboratory forms are bound in press-board once a year.

BLACKSTONE RIVER - Inspection and Sampling

Date	*Weather*			*Temp. Air*
	Am. Steel & W. Co. Pond	*Millbury St. Bridge*	*Greenwood St. Bridge*	*Riverlin St. Bridge*
Time - Temp.				
Height Water				
Current - Rate				
Wind				
Odor - Air				
Color				
Turbidity				
Surface Water				
Light Oil				
Black Oil				
Foam				
Gassing				
Exposed Flats				

Observer

Fig. 2—Form for Report on Inspection and Sampling of Blackstone River

Laboratory Records.—Laboratory bench work on plant samples is recorded in common blank books which are lettered and indexed and, when filled, are filed as original records. Routine data are recorded in the laboratory record or the laboratory daily record from day to day. Comparisons are easily made and the original records are available if desired. Four laboratory books are in use so as to prevent any delay of the work.

In addition to the laboratory record and the laboratory daily record, the supervising chemist uses two 5½ by 8½ in. note books of excellent quality, one of which contains the summary of laboratory work which does not pertain to plant operation, while the other contains results and summaries of all experimental work in the laboratory connected with plant operation as well as experimental plant operation data. In a way of research, the latter notebook is the most valuable record that is obtained.

Such completeness in the matter of records of laboratory work has been the pride of the Worcester plant for a great many years. There is only one essential record missing in connection with operation of present plant. This is a gage-house located on a prepared section of the Blackstone River channel, with apparatus for transferring river water elevations to a chart record located in the laboratory office. In the early days of old plant operation, a section of the river channel was boarded, bottom and side-walls, and charts used with a float in a well at the river bank. In later years, the boards rotted away and flood flows exceeding the height of the sidewalls covered acres of land so that accurate records were impossible.

Mr. Andrew B. Holmstrom is superintendent of sewers and the writer is in charge of the sewage treatment plant.

Regional Government in Ohio

A bill has been introduced in the Ohio legislature carrying with it a constitutional amendment providing for regional plans of government in Ohio. The constitutional amendment, in brief, permits: (1) the legislature to establish alternative forms of county government; (2) one of these forms to be an incorporated county, in which the county government would have power to control the water and sewer system, rapid transit, health and other broad powers; (3) such a county to adopt a charter only if a majority of the voters in the suburbs approve it, and also a majority of the suburbs themselves, in addition to a majority in the City of Cleveland.

Significance and Methods for Determination of Filter Plant Turbidities

Various Devices and Instruments and How They Are Used

By JOHN R. BAYLIS
Physical Chemist, Bureau of Enginering, City of Chicago, Ill.

TURBIDITY may be defined as solid particles suspended in solution, and to be more specific, particles in which none or only a part of the light will shine through. Just how small the particles may be and still be in the solid state is not known definitely, but it is evident they may be so small they do not settle rapidly from water. To distinguish between the coarser and the finer particles the term "colloidal matter" is frequently applied to the finer particles. There may be considerable difference between what the water chemist calls colloidal matter and the classification that would be given the turbidity by the physical chemist. The water chemist means suspended matter that is so finely divided it does not settle rapidly.

The suspended matter almost invariably has a specific gravity considerably greater than that of water, and it seems evident there must be some factor tending to neutralize the action of gravity. An English botanist, R. Brown, discovered in 1928 that small particles suspended in solutions were in a constant state of motion*. This is called the brownian movement. I do not know that Brown offered an explanation as to the cause of this movement, but it is now conceded to be caused from a bombardment of the particles by the molecules or electrons of the solution that are in a state of rapid motion. It is believed that this is largely responsible for the slow settling of the fine particles, especially those known to have a specific gravity much greater than that of water.

Sizes of Particles.—Crystalline particles 5 micra (Micra is the plural for micron. One micron is 0.001 mm.) in diameter or larger will settle fairly rapidly when suspended in water, and if we were concerned with particles this size or larger there would not be much need for filtration to clarify water, for it would likely be cheaper to settle the suspended matter in reservoirs. It is possible to make a suspension that probably will never settle, India ink being a good illustration. Some years ago the writer kept a bottle of water that originally had a turbidity of 5,000 standing without agitation for 5 years and it still had a turbidity of 15 to 20. This, however, is the exception and not the general rule, for most turbid waters will become fairly clear when allowed to stand in bottles for a few weeks.

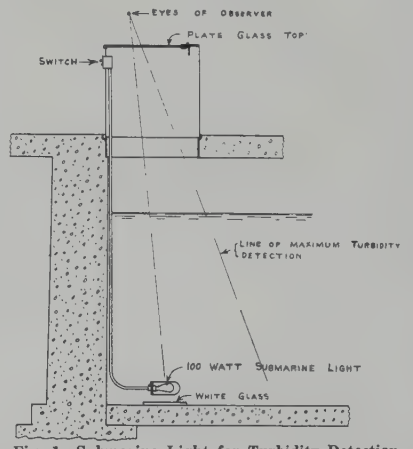


Fig. 1—Submarine Light for Turbidity Detection

It is believed that very few particles of solid matter below 0.1 micron in diameter occur in most surface waters. It is really the particles between the size of 0.1 micron and 2 micra that concern us most. This happens to be about the size of most of the bacteria that occur in water. Should a particle 3 or 4 micra in diameter happen not to become entrapped in the coagulation of chemically treated water it likely would be filtered out, but a particle 1 micron in diameter or less not entrapped has a fairly good chance to pass through the filter. Now if this particle happens to be a bacterium it also has a very good chance to pass the filter.

It cannot be stated that bacteria are removed in direct proportion to the turbidity removed by filtration, for it is known that they are not, but it is in the same direction. If the turbidity of the raw water was 100 and the number of bacteria were 1,000 per cc., reducing the turbidity 99 per cent probably would not reduce the bacteria more than 90 per cent, whereas reducing the turbidity 99.9 per cent may reduce the bacteria 99 per cent. It is evident that the actual results may vary greatly from these figures for different waters, yet they are not so greatly in error for average results. They are given more to illustrate the point than to state actual efficiencies that may be expected.

Turbidity Removal as Index.—Turbidity removal may be used as an approximate index of bacterial removal, and while not very accurate it has the advantage that it can be determined immediately whereas it is necessary to wait 24 hours for bacterial counts and 4 to 5 days for B. coli determinations. It is necessary to know something about how the bacteria usually run in the water to predict the bacteria that may be expected from the clarity of the filtered water, but after one or two years' operation of a filter plant where accurate turbidity measurements have been made results may be predicted fairly closely.

If reducing the turbidity to 1.0 by filtration reduces the bacteria 90 per cent and reducing it to 0.2 reduces the bacteria 95 to 98 per cent, it seems that this increased efficiency is well worth while for polluted waters. These are really conservative figures and may be expected at most any filtration plant.

What Operating Records Showed.—Several years' operating records at the Baltimore filtration plant after it was first put in operation revealed irregularities that were surprising. Having no accurate turbidity measurements on the filtered water it was difficult to place responsibility for the erratic results. We were really quite anxious to improve the quality of the filtered water, for the chlorine required to make the water safe was so high that chlorine tastes were frequent. Every possible cause for the erratic results was investigated, and nothing seemed to offer an explanation unless it was due to the water not being filtered perfectly clear at times. Turbidity measurements on the filtered water were being made at that time by comparing the water with standards of known turbidity in ½ gal. bottles. Our lowest standard was turbidity of 3.0, and I presume any turbidity less than about 2.0 was usually recorded as being zero, especially as we were anxious for the records to show zero readings. It may be possible to detect a turbidity of 1.0 in bottles by making very careful observations, but the average laboratory worker is usually not so careful.

To see if any relation could be established between the clarity of the filtered water and the bacterial removal, turbidity measurements were then made as carefully and accurately as it was possible to make them by bottle comparisons. It was soon found that very poor bacterial removal coincided very closely with slightly turbid water. This pointed to the need of more accurate

*Brown, R., Phil. Mag., 4, 161. (From Bancroft's Colloidal Chemistry.)

turbidity measurements on the filtered water. Then began the effort to perfect some device for estimating low turbidities. Perfection of suitable instruments was not accomplished in a few days or a few months. In fact the work was started in 1918 and it was not until 1921 that success seemed assured.

Developing Turbidity Detecting Devices.—Perhaps it might be well to review briefly some of the early work. It was soon found that there was need both for a laboratory instrument where the turbidity could be measured accurately and for some kind of device for installation on individual filters. Many devices were tried, mostly of our own conception, and considerable money expended. While on a trip in 1918, Mr. Armstrong, filtration engineer of the Baltimore plant, saw a submarine light in the clear water reservoir of the Cincinnati plant. My memory may not be correct as to it being this plant. Immediately he had one installed in the clear water reservoir of the Baltimore plant. This was a great revelation, for the water was frequently so cloudy that we were undecided at first whether to leave the light where it might be observed by all, or to put it in some place where only certain employees would have access to it. It might be said that some such device is almost an essential for every filtration plant if a uniform quality of water is desired. It does not take the place of the instruments that will be described later, for each device serves its own specific purpose. A very good arrangement of the light is shown in Fig. 1.

After installing the light in the clear water reservoir it was thought at first that the light would answer the needs of the filter operators so that as soon as the water showed a slight cloudiness the chemicals could be increased. But it was soon found that increasing the chemicals did not always clear up the water. Finally this was found to be due to flocculated matter passing the

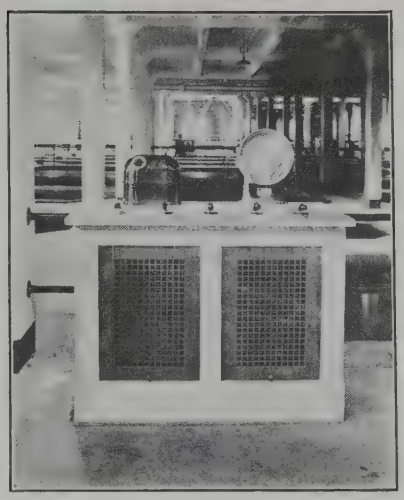


Fig. 3—Floc Detector Mounted on Filter Operating Table

filter beds that were allowed to run 100 to 200 hours between washings. The last half of the time in service frequently passed a large percentage of the coagulated matter going on to the beds. Fortunately the coagulated matter was settled out quite low before the water went to the filters, otherwise the filtered water would have been quite turbid at times from this cause. There was a belief some years ago that a certain amount of the coagulated matter should go to the filters to make them function properly, and that the coagulated water at Baltimore was being settled too clear. The water was settled to a turbidity of 2 to 5 when alum was used for the coagulant. Experiments later proved that for this plant the clearer the water going on to the filters the better.

When it was found at Baltimore that flocculated matter was passing the beds orders were issued to allow filters to run not over 36 hours between washings regardless of the loss of head. Under this order filters were being washed with losses of heads of only 3 to 4 feet in the colder months. However, it prevented flocculated matter from passing the beds. Then when the water showed a slight turbidity in the clear water reservoir it could be attributed to insufficient chemical treatment and increasing the chemicals usually caused it to clear up. A fixed limit on the time between washings could not be regarded as ideal operation, yet it was the best that could be done at the time.

Device for Detecting Flocculated Matter.—In addition to the work which was under way on the laboratory device for making quantitative turbidity determinations, work was started on a device for detecting the flocculated matter which might be installed on the individual filter units. On two occasions it was thought that something had been perfected that would answer the needs of the filter operators. A few of the filters were equipped with the devices only to find that they would not work satisfactorily.

It would be too long a story to relate all the developments leading up to the perfection of the floc detector for installation on filter operating tables shown in Fig. 2 and 3, and the laboratory instrument shown in Fig. 4. Fig. 2 illustrates a homemade instrument and Fig. 3 one along the same lines as manufactured by one of the filter manufacturing companies. A suitable floc detector was developed first. It gave very sensitive detection of the flocculated matter passing the filter beds, but did not give quantitative determinations. A device somewhat similar to the one shown in Fig. 2 was constructed for use in making quantitative determinations. This is shown in Fig. 5. About the only difference is space for two flasks, one of them to contain a standard of known flocculated matter. Quantitative estimation of the flocculated matter has not grown into favor, and there are only a few plants in which sensitive devices have been installed on the filter operating tables. Perhaps there are many waters where such devices are not needed; however, it is believed that there are many plants where they would be of great aid and for some waters they are almost an essential.

Specific Purpose of the Floc Detector.—The floc detector is not much good for observing the fine turbidity, for a fine turbidity of 0.5 to 1.0 cannot be detected. It is very sensitive though for flocculated matter. Particles that would not produce a turbidity of 0.01 are readily detected. The specific purpose of the floc detector is as the name implies, to detect suspended flocculated matter passing filter beds. It is better that it is not so sensitive to the finer particles for it would be more difficult to detect flocculated matter passing the beds. It is very important that the kind of turbidity passing the filter bed be known. If it is flocculated matter

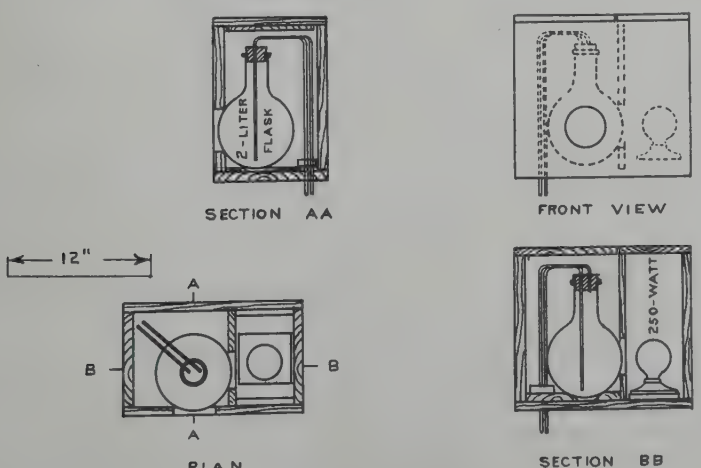


Fig. 2—Floc Detector

the filter should be washed, whereas if it is fine turbidity the chemicals should be increased.

How Turbidity of Filtered Water Was Controlled.—It might be well to relate how the turbidity of the filtered water was being controlled at Baltimore by the plant operators while the writer was there. The filter operators kept a close watch on the submarine light in the clear water reservoir and also made frequent observations in the floc detectors located on the operating tables. If the light in the clear water reservoir showed a slight cloudiness all filters were examined. If none of them showed flocculated matter passing, or so little that it was evident that this could not be responsible for the cloudiness the matter was reported to the chemical controller attendant who had instructions about increasing the chemicals. If the chemist was on duty it was also reported to him so that he might give additional instructions if necessary.

A turbidity of 0.2 is readily noticeable in the clear water reservoir if the light is under 6 or more feet of water and is near a concrete floor or some other dull surface. Just why a dull surface like that of concrete gives better detection of the turbidity is not known, but it is a fact nevertheless. Some have made the mistake of having a white surface on the bottom of the reservoir with the belief that it would show the cloudiness better. A white surface is all right directly under the light as shown in Fig. 1, but the white surface should not be more than 18 to 20 in. in diameter. Another mistake that is frequently made is not providing enough space around the light. The light may be near a side wall but there must be plenty of space away from the wall. What is seen is a reflection of the light from the particles in suspension and it is evident that the particles must not be directly over the light. Looking at an angle of 10 to 20 degrees from a line direct to the light seems to give the best results when the eyes of the observer are 8 to 10 ft. above the water surface. In other words, the area of the most sensitive turbidity detection is a circle around the light and not the area directly over the light.

The light in the clear water reservoir is just as indispensable as the floc detectors, for it is at this point where water that has not received sufficient chemical treatment is first detected. The light should be located where the water can be observed shortly after it has passed the filters, otherwise it will take a longer time to get the treatment corrected. It is true that water greatly undertreated may be detected by skilled operators after it passes the mixing basin, but slight undertreatment which will cause the turbidity to increase a little in the filtered water cannot be detected until after it passes the filters.

The Laboratory Turbidimeter.—The purpose of the laboratory turbidimeter shown in Fig. 4 is for making accurate quantitative measurements. It was selected as the most suitable means of measuring the turbidity of filtered water after many devices had been tried. A practical instrument must not be too cumbersome and it must give comparisons easily distinguished; that is, it must give comparisons whereby a turbidity of 0.2 is readily distinguished from a turbidity of 0.1 or 0.3. The first attempt to measure low turbidities was to pass rays of light through water in a dark room, somewhat in the principle of a Tyndall meter. The results were none too encouraging or at least it did not seem that an instrument along this line would be practical for routine turbidity measurements. Long tubes with a light underneath were tried next. An instrument using two-inch glass tubes 5 ft. long was constructed. This was a little improvement over the way turbidity measurements were being made in bottles prior to this time. On the basis of the long tube experiments eight of the filters in the plant at Baltimore were equipped with iron tubes about 8 ft. long, having a glass plate at the bottom and a light underneath the glass. This was prior to the perfection of the floc detector. It was soon found that turbidities readily noticeable by the light in the clear water reservoir could not be distinguished in the long tubes.

Even though the long tubes for the filters were a failure, use of the device containing the 2-in. glass tubes was continued in the laboratory. It was at least better than comparing with standards in bottles. Perfection of the floc detector suggested that a side light for the tubes might be better than one underneath. Various arrangements of the light and the tubes were then tried. Finally an instrument along the lines of that shown in Fig. 4 was tried. The glass tubes used at first were the 75 cm. tubes for the Jackson candle turbidimeter. This did not give very good results. Then colored light were tried, which finally led to the present instrument. So many things had been tried and resulted in failure that many things were being tried with not much idea of what might be expected. Blue is not the only colored glass that may be used, but blue is a color in which variations in the shade are easily distinguished.

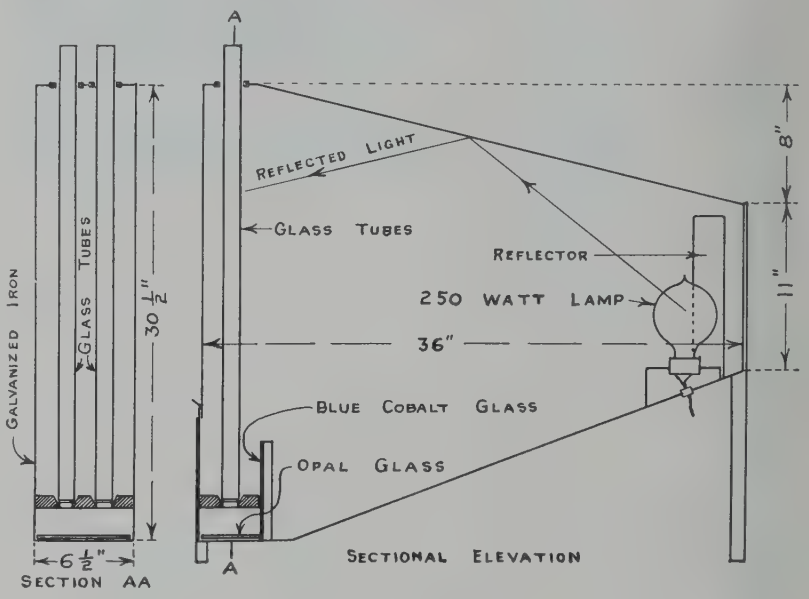


Fig. 4—Details of Turbidimeter

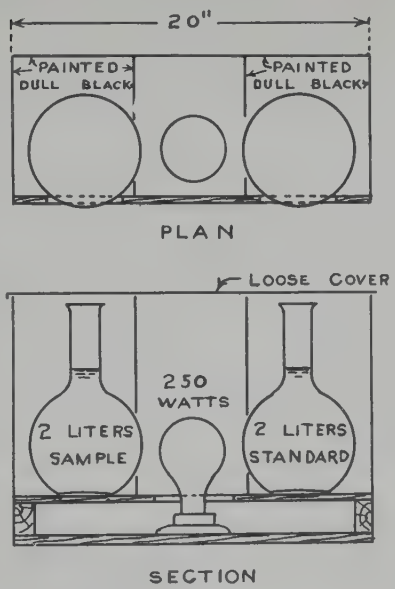
In attempting to make the instrument extremely accurate for low turbidities the range it covers is not great. The most accurate comparisons can be made when the turbidity is between 0.0 and 1.0, but it is suitable for comparisons up to a turbidity of 2.0. Some are of the opinion that if it had been made a little less sensitive and covered a wider range of turbidity that it would be more useful. This may be true, but when it is desired to produce water in which the turbidity is not more than 0.2, it seems that something in which a turbidity of 0.1 may be readily detected is desirable. There is no fault to find with other instruments, and it is hoped that one even more simple and useful will be perfected. It is believed, however, that the present instrument is sensitive enough for water works laboratories and will answer the purpose in case nothing more convenient and cheaper is devised.

Turbidity Measurements.—The best procedure for making turbidity measurements is to first test the total turbidity with the instrument shown in Fig. 4. This instrument and the procedure for making the standards and the test is explained in two articles

which have been published already*. Record the results as the total turbidity, for it includes all the suspended matter. If a floc detector as shown in Fig. 5 is available use it for determining the floc turbidity. Subtracting the floc turbidity from the total turbidity should give the fine turbidity. If no floc detector is available fairly good results may be obtained by filtering the water, after the total turbidity determination has been made, through a No. 12 Whatman folded filter paper. The paper should be washed thoroughly by filtering through at least one liter of clear water. It may then be used for filtering several samples of water if only a small quantity of flocculated matter is present. It should not be used after it begins to show signs of clogging. Test the filtrate for turbidity the same as for the total turbidity and record the results as the fine turbidity. The difference between the total turbidity and the fine turbidity should give the approximate floc turbidity.

An arbitrary standard of 0.2 fine turbidity and 0.05 floc turbidity has been set by the writer as that beyond which the water should not exceed. This seems to produce water that is satisfactory in every respect for domestic uses. In the practical operation of filtration plants the coagulation should be increased if the fine turbidity exceeds 0.2 and it may be reduced if the turbidity is less than 0.2. When the floc turbidity exceeds 0.05 the filters should be washed more often, and when it is less than this amount the filters may be allowed to run until the loss of head reaches the maximum. If only the total turbidity is measured, and it exceeds 0.2, there is no way of telling whether it is due to fine turbidity alone, floc turbidity, or a mixture of the two. Table I gives the daily records for a period of several days on two occasions in which the filtered water of a certain plant materially exceeded what it should have been. Twenty days are given. It will be noted that out of the 20 there were 8 days in which the fine turbidity exceeded 0.2 and the coagulant should have been increased and that there were only three days in which the floc turbidity did not exceed 0.05. For some of the days both the coagulant should have been increased and the filters washed more often. There were 6 days in which the fine turbidity was not over 0.1. On these days the total turbidity was high, yet the coagulant could have been reduced. It might be well to state that these records are not typical of average operating conditions for this plant. They were the two worst conditions experienced at the plant. The average results were good.

*Baylis, John R. J. Am. Water Works Assoc., 11: 4, 284, July, 1924. Ind. & Eng. Chem., 18: 3, 311, March, 1926.



LABORATORY FLOC DETECTOR

Fig. 5—Laboratory Floc Detector

Accurate turbidity measurements on the filtered water are of great aid in the efficient operation of any filtration plant, and it is evident that the cause of the turbidity should be known. No one device will answer all purposes though it may result in improved operation. It is true for some waters that there is not much danger of flocculated matter passing the filters, and in these cases there is not much need for the floc detectors, yet they should not be omitted unless several years of careful observations show that they are not needed. Even then they would be worth the cost to detect occasional breaks in the beds.

Table I—Turbidity Measurements Showing the Importance of Determining Both the Fine Turbidity and the Flocculated Matter

Date	Total Turbidity	Fine Turbidity	Floc Turbidity
Jan. 13	.2	.2	.04
" 14	.3	.3	.04
" 15	1.5	.4	1.00
" 16	1.0	.2	.80
" 17	2.5	.1	2.40
" 18	2.5	.1	2.40
" 19	2.5	.1	2.40
" 20	1.0	.1	.90
" 21	4.5	.1	4.40
" 22	7.5	.1	7.40
" 23	.8	.2	.60
" 24	.2	.2	.04
Sept. 18	1.0	.8	.20
" 19	1.3	1.1	.20
" 20	1.5	1.3	.20
" 21	.3	.2	.10
" 22	.3	.2	.10
" 23	.3	.2	.10
" 24	2.0	.6	1.40
" 25	2.0	1.0	1.00

Acknowledgment.—The foregoing is a paper presented, Feb. 4, 1929, before the Kansas Water Works Association and the Seventh Annual Three Day School at the University of Kansas, Lawrence, Kans.

Service Lines

Useful Information on Installation and Care

By W. C. HAWLEY
Chief Engineer and General Superintendent, Pennsylvania Water Co., Wilkinsburg, Pa.

ONE of the most important things in the installation of service lines is the tapping machine, with which the main is drilled, the hole tapped and the corporation cock screwed into place under pressure; that is without the necessity of shutting off the water pressure by closing gate valves in the main. In choosing be sure to get a machine which has been used by others satisfactorily under similar conditions and one that is not too heavy for easy transportation and handling.

Tapping the Main.—The main should be tapped at an angle of about 45 deg. from the vertical where there is any danger of frost. Where there is no such danger it may be tapped on top and thus provide a means of escape for air which may accumulate in the main.

Many water works men believe that a corporation cock larger than the 1-in. size should not be used and even the 1-in. size is not used by some, where pressures are high. This avoids the danger of splitting the pipe by the wedge action caused by screwing the corporation cock into the main. Where 1½-in. or 2-in. service lines are needed it is better to insert two or more ¾-in. or 1-in. corporation cocks at safe distances from each other and staggered, that is not put in along the same line on the main, thus avoiding the danger of splitting the pipe as explained above. Where two or more corporation cocks are used they can be connected with goose necks to a header attached to the larger pipe.

Service lines should be laid at depths sufficient to protect them from frost. This depth will vary according to kind of soil and the amount and degree of cold weather to be expected and no chances should be taken. Remember the winter of 1917-18.

Laying the Service Line.—A service line should be laid at right angles to the street in which the main is laid and it should not be laid in a sewer trench as any leakage will probably find its way into the sewer instead of going to the surface. The only exception to this rule should be when the trench is in rock and then the sewer trench should be at right angles to the street and not at about 45 deg., as sewers are usually laid, and the water pipe should be placed on a bench on the side of the trench at the proper depth.

The service line to the curb should be laid by competent and experienced men. The consumer's service line should be inspected in open trench to insure its being of proper material and workmanship and at proper depth to make it safe from frost. Our company

has found it advisable to have the consumer's service line laid first and inspected. The company's service line is then laid and the connection at the curb to the consumer's service line made by the water company's employes.

Capacity of Service Line.—The capacity of a service line depends upon the pressure at the main, the length of the service line, its internal diameter and the character and condition of its interior surface. The pressure and the length are known quantities. The character of the interior surface and its future condition are matters determined by judgment and experience, so that the only really unknown quantity is the diameter, and the proper diameter will depend upon the demand made upon the service line by the occupants of the premises supplied through the various fixtures installed for water service. For the ordinary dwelling a demand of about 1 cu. ft. per minute is not unreasonable. As the number of people and fixtures increase the demand will be increased correspondingly. With normal pressures of 60 to 100 lb. and streets of 60 to 80 ft. width and houses at 20 to 30 ft. back from the curb line, a ¾-in. service line in good condition should meet the demand of the ordinary family. We must recognize, however, that with the installation of fixtures requiring water delivered at rates in excess of those which were demanded a few years ago, such as laundry trays with ½-in. spigots, shower baths, etc., we must be prepared to deliver water at rates somewhat in excess of those which were adequate a few years ago.

Methods of Removing Deposits.—With some waters there is a tendency for the deposit of silt or oxides of iron and manganese in the service lines, which in course of a few years may cause noticeable reduction in capacity. If this is likely to occur, it must be taken into consideration in deciding upon the size of service line which is necessary.

Incidentally, there are methods of removing such deposits in lead or other pipes with smooth interior surfaces without the necessity of taking up the service line or going to large expense. The use of a tissue paper plug forced through the service line by a force pump has given good results where the pressure in the main is not too high. The paper soon disintegrates and is not objectionable. Gum drops have been used for the same purpose and one of the best materials is coarse salt. The latter can be used when pressures are high.

Demand for Larger Service Lines.—In recent years there has been a rather general demand for larger service lines and meters as well, due to the introduction of Flushometers. If these fixtures used larger quantities of water it would be easier to convince the average water works man that the water utility should increase its investment in service line and meter for the purpose of giving such service. The fact is, however, that the Flushometer probably reduces somewhat the total amount of water used, and sooner or later it causes water hammer. In some places the demand for larger service lines has been granted, but in most places it has been refused and the satisfactory use of the Flushometers has been made possible by the installation of an air tank connected to the water pipe in the building supplied.

It is difficult to convince a consumer that he should not be given a large service line. He will argue that he wants a connection to the main which will give service on the second or third floor whether water is being drawn in large quantities in the basement or not. He does not appreciate the increase in investment required to give that kind of service nor that the amount of water used will not be materially increased. Explanations to the effect that a large meter is not as sensitive on small rates of flow are not appreciated by him. The most effective argument is in the case of a water utility which has a service charge based upon the size of the service line or the size of the meter. He can understand and appreciate a larger service charge, especially when it does not pay for any water.

The rules of most water utilities provide that there shall be but one service line to each property supplied, except sometimes in the case of large buildings. This is a reasonable rule and has been approved by Public Service Commissions. There is no good reason for the water supply for a building being taken from two or more service lines with two or more meters to be looked after and maintained and two or more accounts to be kept.

Laying Service Lines to Vacant Lots.—The demand that service lines should be laid to vacant lots, etc., before pavement is put down is one which has caused much trouble. Where it has been tried it has been generally unsatisfactory. No one can foretell the size of a building which will be erected on a lot at sometime in the future, nor what will be the demand for service. Wide lots are frequently subdivided into narrower ones so that the service lines which have been put in are too few. The proper location of the service line cannot be foretold and many service lines which have been put in before paving have never been put into use. The Public Service Commission has refused to compel the water company to install service lines before pavement is laid. It is probable that no type of pavement has as yet been put down which cannot, with proper care, be replaced when it is necessary to cut through it to lay a new service line or make repairs. The back-filling of trenches and the replacing of such pavements demand the utmost attention on the part of the water works manager and the work should be done so that it is not a source of reasonable complaint on the part of the municipality.

Back Filling Trenches.—In places where crushed slag can be obtained it is becoming quite customary to use it for back-filling trenches after 10 or 12 in. of clay or earth has been placed and tamped over the pipe. The slag can be wet and tamped into place without danger of further settlement to any extent. Temporary pavement can be put over it and in two or three weeks it is ready for the placing of permament pavement with no danger of further settlement. A better arrangement would be for the municipality to take over the back-filling of all trenches and the replacing of pavements over them for which the water utility would pay a reasonable fee.

Service Line Records.—And one thing more. There should be kept a record of every service line, showing its size, material, length, location, etc. This data should not only be written but there should be a sketch so that it will be possible with the information given to go out onto the street and by making two to four measurements locate the service line accurately. These measurements should at least be from the property line of the intersecting street and from the curb to the tap. There should be two or three check measurements from objects as nearly permanent as possible, such as a fire hydrant, a gate valve box or the corner of the curb or from the corner of a building. Measurements from trees, telephone or electric light poles, etc., are not of much value, as trees are cut down and poles are moved. Even curb lines are changed at times, but there should be enough measurements made so that although one or two of the objects from which they are made are moved, it will still be possible to locate the service line. In these days of permanent pavements it does not make the municipal authorities feel very good and it is expensive to have to dig through the pavement in three or four places to locate a corporation cock when it might have been avoided by the keeping of proper records. Such records should be checked and brought up to date at every opportunity. Curb boxes should be maintained in good condition with the tops at the proper elevations and if service lines have always been put in at right angles to the street the location of the corporation cock can be found at least approximately if the distance of the main from the curb is known. The curb box should be inspected every few years and kept in good condition, ready to operate in case of a leak doing damage in the property or the necessity of shutting off for neglect to pay bills, etc.

Acknowledgment.—The above is an abstract of a paper presented at the last annual meeting of the Pennsylvania Water Works Association.

Meter Accounting and Reading by the Water Department of Detroit

How Detroit Reads 245,000 Meters

By W. C. BOWEN
Supervisor Assessment Bureau, Department of Water Supply, Detroit, Mich.

THE Assessment Bureau is chiefly concerned with the problem of determining how much water is delivered to each of the department's 245,000 customers through an equal number of service lines, and such other activities as are naturally allied.

Ninety-nine per cent of the service lines are metered, which fact goes a long way towards solving the problems of the bureau. It is, however, no small task to read 245,000 meters at least four times a year and many of them more often. To accomplish this in the most satisfactory manner the following plan was worked out and put into operation two years ago and is proving to be by far the best system that has to date been tried.

City Divided Into 36 Districts.—The city was first divided into three zones, each having approximately the same number of meters within its boundaries, and were named Eastern, Western and Central. Each zone was then divided into twelve districts. Considering the number of meters in service at that time it was necessary to so divide the zones that each district would have about 7,000 meters. Districts were so numbered that the number of the district not only designates the district but also the zones, namely, districts of the Central zone were numbered from 11 to 22, inclusive, Western from 41 to 52, Eastern from 71 to 82. The intervening numbers were left for expansion.

It is now noted that the city has been divided into 36 districts, each of which must be read once every three months, making it axiomatic that one zone or twelve districts must be read every month. As there is but an average of 24 working days to a month it is seen that only two days could be allowed for the reading of each district.

1,685 Route Books.—Districts were then divided into routes, each containing a sufficient number of meters to constitute one day's work. The number of meters in each route vary in accordance with the territory ranging from 120 meters in business and factory centers to 180 in some residential sections. Each route was given a number so that, being given district and route any reading sheet can be immediately located. Reading sheets for each route were then locked into a specially designed binder, upon which was printed the district and route. We have at present 1,685 of such route books. They are filed in a specially designed cabinet in such a manner as to be most readily procured. A card index system, wherein streets are arranged alphabetically and in rotation as to house numbers, serves as a key to the route books.

Readers report each morning to the main office, turn in the books completed the previous day, receive the books assigned them for that day and immediately set out for their route. It is well understood that, barring mishap of some kind, no excuses will be accepted for failure of a reader to complete his route.

Checking by Assessment Clerks.—Following completion of route books they are scanned by assessment clerks, who go over each book, sheet by sheet, checking the readers' computation, considering the probable correctness of each reading, ordering check readings where necessary, writing up "pick up slips" for all meters that were for some reason passed by the reader, reporting meters out of order and new jobs ready for meters, computing and entering construction service charges, estimating consumption (of which more will be said later), as well as various other details that are necessary in order to get the books in shape to turn over to the billing bureau.

As above mentioned, meters that were passed by the readers are caught by the assessment clerks who make out pick-up slips. There readings are obtained the following day by a group of readers known as "pick-up men." Any meter passed by this group or about which additional information is desired is turned over to the night reader, meter reader foreman or chief inspector, as the case may be. From this it is noted that the route books are a long way from being ready to turn over to the billing bureau when turned in by the readers as completed.

Delivery of Bills.—The Assessment Bureau is also responsible for bill delivery. Six men are assigned to this work. All bills prepared one day are delivered the next day. The schedule calls for the bill to be in the customer's hand 15 days after the first call of the reader. Ways and means are now being considered as to how this period can be still further shortened.

Method of Estimating Consumption.—We believe that a special paragraph describing our method of estimating consumption is deserved, for there is no other duty of the assessment clerks that requires that fine degree of good judgment and application of common sense as does estimating the amount of water consumed by a certain customer during a definite period. It is probably needless to say that this method of arriving at a consumption is resorted to only after all other methods have failed, but even at that, unfortunately the necessity often arises. An average of 3,500 accounts are checked each day by the assessment clerks and of this number there is an average of 300 accounts that for some reason no reading could be obtained. The most common reason is the inaccessibility of the meter and next to that the fact that the meter does not indicate true consumption. An estimation in case of the former is not so serious, as a reading will eventually be obtained at which time any error in estimation is corrected; but where the meter is out of order, that's different: there will be no later reading. Our estimates vary from a few hundred feet to a few million feet or as expressed in money from the minimum bill of $1.25 to well over $1,000. There can be no definite rules set up to govern estimates as there are no two cases just alike. Our limited space forbids a detailed treatise on this subject, but sufficeth it to say that all available information, such as a record of past consumptions and a report on present conditions at the premises is gathered together and considered before the estimate is made. Often in case of large consumers a personal call to the premises is made when an opportunity is given the owner or an official of the company to express his opinion as to the probable consumption. We have found the large consumers, particularly large institutions, always ready and willing to co-operate and meet us half way in a matter of this kind.

Construction Service Charge.—Provision has been made for supplying water for building purposes by installing services before there is any possibility of setting a meter and allowing use of the unmetered line until the building is completed and occupied. While this arrangement is a decided accommodation and convenience to the builder and owner, it is just another problem for the assessment bureau, which much determine how much water was used through each service before

the meter was installed. After trying several plans with more or less unsatisfactory results, the plan now in use was decided upon and is working out very satisfactorily. The idea of estimating the consumption or assessing a fixed charge known as the building tax for each new building and varying according to types, was given up and superseded by a monthly flat rate charge known as construction service charge, same to run from the date of service installation to the date of meter installation. This charge is applied only to ¾ in., 1 in. and 1½ in. services, which constitute 95 per cent of the total.

After considering the amount of water actually required for construction of certain type buildings, the average amount wasted, the usual type of building using a ¾ in., 1 in. and 1½ in. service, the rate of $.75 per month for ¾ in. and $1.50 for 1 in. and 1½ in. service was adopted as being sufficient to cover in the aggregate the cost of this service.

Under this plan accounts are opened on the day service is installed and allowed to run until meter is installed and up to the time of the next regular billing period, at which time the number of months of unmetered service is noted and multiplied by the proper monthly rate, which amount is billed as the construction service charge. Considering that there is an average of seventy new accounts opened daily the year around it is readily understood why this plan is popular with the assessment bureau, as each account is handled in precisely the same manner, whereas under the old plan each new account had to be individually considered; not only that, but it establishes a definite date of collection and a definite rate. It removes all opportunity for a customer to complain that he was charged more than his neighbor for like service, or that he obtained his water supply for building purposes from the county ditch.

For the benefit of the customers who dislike this flat rate plan, arrangements have been made to install meter at any time upon request of the owner, provided that proper preparation has been made for its reception.

Service lines over 1½ in. in diameter are used by buildings of such various types and sizes that this plan is not applicable. In all such cases the building tax is arrived at by ascertaining the amount of the various materials used in the building and applying the rate so based as has been adopted by the board. To this is added the regular service charge for the period of unmetered service, the total being the building tax.

Special Readers for High Consumption Meters.—High consumption meters are read monthly by special readers whose duty it is, in addition to reading, to see that they are so functioning as to constantly indicate true consumption. Frequent tests and minor repairs are made on the job. They have so arranged their routes that one of their regular readings will be made at the time of the scheduled billing reading. These readings are turned over to the assessment bureau where they are transferred to the regular reading sheet and the accounts prepared for billing.

As has been before mentioned 99 per cent of the service lines are metered, the other 1 per cent for various reasons are not. These few accounts are carried on assessed rate, the rate being determined in the usual flat rate method of basing it on the number of openings and the purpose for which the water is used.

Special Assessment Record. — The board's desire to furnish water for every legitimate purpose and in the manner most convenient for the consumer has necessitated the keeping of a special assessment record. Every day applications are made for temporary water service, and in those cases where a permanent service installation would not be practical nor the expense justified, the applicant is given permission to use a fire hydrant.

It is the assessment bureau's problem to determine how much water is used for the above mentioned purposes and in what amount each permit holder is to be billed. A clerk, known as special assessment clerk, is assigned to this work. A description of our methods of determining water consumption in such cases would be too lengthy to be included in this paper, as it is obvious that there must be a different method for nearly every case, but as an illustration we will cite that of pavement construction.

At the end of each paving season we obtain from the records of the department of public works the amount of paving done by each contractor. From these records the yardage of concrete is computed. Yardage times known amount of water required per yard plus a certain percentage for wastage equals approximate amount of water consumed.

During the year 1926 $11,810.55 was paid to the department for the use of water from fire hydrants ranging in amounts from $1.00 to $3,537.65.

The assessment bureau receives and investigates all service bill complaints. It is the aim of the bureau to go full length to satisfy each and every customer by check readings, and investigating for cause of high bills. Very few complaints are carried to the adjustment committee of the water board.

The bureau has charge of the addressing machine room consisting of the addressing of water bills, making of addressograph plates, printing of forms and notices used by the department of water supply and allied work.

Acknowledgment.—The foregoing is taken from a descriptive survey of the Detroit Department of Water Supply, issued last fall by the department.

Revenues and Expenditures of Cities

The U. S. Bureau of Census, Department of Commerce has just issued a bulletin giving the financial statistics of cities having a population of over 30,000, the figures being for the year 1927.

Assessed Valuation and Tax Levies.—For the two hundred fifty cities having a population of over 30,000 the assessed valuation of property subject to general property taxes for city purposes amounted to $74,731,205,845, or a per capita of $1,749.47.

The total levies on the property subject to general property taxes in these cities for the governments of the cities, counties, states, school districts, and all other governmental units for all purposes amounted to $2,278,379,544, or an average for each person of $53.34.

Revenues.—The total revenue receipts in 1927 of the 250 cities having a population of over 30,000 were $2,945,511,729, or a per capita of $68.96. This was $713,084,994 more than the total payments of the year, exclusive of payments for permanent improvements, but $378,874,622 less than the total payments, including those for permanent improvements. In only seventy of the cities was there sufficient revenue to meet all payments during the year. The payments in excess of revenue receipts were met from the proceeds of debt obligations.

Governmental-Cost Payments*.—The total cost of government in 1927 of the 250 cities in this class amounted to $3,324,386,351. An analysis of this total shows that the costs for the operation and maintenance of the general departments were $1,750,707,093, a per capita of $40.98, and representing 52.7 per cent of all costs of the 250 cities; operation and maintenance of public service enterprises, such as waterworks, light plants, public markets, and similar enterprises, $162,470,940, a per capita of $3.80, and 4.9 per cent of the total; interest on debt, $319,248,702, a per capita of $7.47, and 9.6 per cent of the total; and for outlays, or permanent improvements of general departments and public service enterprises, $1,091,959,616, and 32.8 per cent of the total cost.

Expenses for Operation and Maintenance of General Departments: 1927

	Total (000 Omitted)	Per Capita
All general departments	$1,750,707	$40.98
General government	148,061	3.47
Protection to person and property	350,341	8.20
Health and sanitation	176,996	4.15
Highways	157,198	3.68
Charities, hospitals, and corrections	106,492	2.49
Education	668,263	15.65
Recreation	60,364	1.41
Miscellaneous	82,992	1.94

*The governmental-cost payments include all payments for the year, whether made from current revenues or from the proceeds of bond issues. The proceeds from the issuance of debt obligations are not considered revenue receipts.

Unusual Conditions Discovered through Pitometer Water Waste Surveys

A Discussion of Particular Interest to the Water Works Superintendent

By H. E. BECKWITH
District Manager, The Pitometer Co., New York, N. Y.

IN the 30 years our company has been conducting water waste surveys improvements in our methods of operation have come as often from the criticism and helpful hints of persons outside our organization as they have from the development of new ideas on our own part. Consequently, in calling to your attention those conditions which we have encountered in our work, I am not prompted by any unholy joy in pointing out the mote in my brother's eye. It is rather by way of returning in small measure the helpful courtesies shown us by the men in the water works field, and with the hope that you may find some helpful hint in the conditions we have found in other plants.

When the Valves Were Closed.—It is, of course, very common for us to find closed valves. Your attention is called to two such instances: In the first of these an entire town of some 20,000 persons was being fed through four 6-in. mains, because a valve on the main 16-in. feed was closed. Moreover, this was the only valve in the entire system found closed, showing that care was taken to check up on the valves. Furthermore, and this is of special importance, it was the only geared valve in the system. When the operating nut on the gear was turned in a clockwise direction, the valve stem was turned counter-clockwise. As the valve stem on this valve closed in the same direction as all other valve stems in the system, it was necessary to turn the operating nut in the direction opposite to that of every other operating nut in order to close the valve. Someone failed to take this into consideration, with the result that the valve had been kept habitually closed.

In the second case, the hydraulic grade line was apparently lower at one point than it was at another point on the same line, ¾-mile further from the source of supply. This was on the system of a small company serving several miles of territory with laterals feeding directly off one long main, or rather it had been one long main originally. For 1½ miles of its length it had later been paralleled with another main. This second main was tied to the original main at no place other than at its ends, and no laterals came off of it. A study was being made for the purpose of reinforcing the system. When the hydraulic gradient for the system, as determined in the field, was plotted on cross-section paper, it was found that midway between the ends of the two parallel mains the hydraulic grade line was lower than at either end. Subsequently, the valve on the reservoir end of the "old" main was found to be closed. All water being used along the mile and a half of parallel mains had to go to the farther end and then feed back toward the reservoir. Opening the closed valve, of course, took the sag out of the grade line and increased pressure below the point where the valve had been closed. The trouble in this case was caused by right and left-hand valves being indiscriminately sprinkled throughout the system. Volumes could be written about the trouble caused by indiscriminate use of both right and left-hand valves in the same system. This is merely another example of the results of this practice.

Why the Supply Main Delivered No Water.—Speaking of hydraulic gradients, there is the case of the city whose officials had believed their system was being fed by two mains from the reservoir. A pitometer test proved, however, that there was no flow through one of these pipes. Further investigation showed that this main at one point actually lay above the water-level of the reservoir. After the line was lowered, its vacation was over and it went to work delivering water to the city.

Accounting for a 50 Per Cent Loss.—Another very interesting case was that of a city which had originally been served by two separate companies. Later, these companies were merged and the distribution system was interconnected. Each of these companies originally secured its water by gravity from a mountain reservoir, the reservoir of one company being 12 ft. higher than that of the other company. Since the complete metering of this system a few years ago the meters through which water was sold had accounted for a little less than 50 per cent of the water shown on the Venturi meters installed at the reservoirs. Our tests showed that during the night, when the use of water in the system dropped low, the water fed out of the higher reservoir into the lower. It is the nature of a Venturi meter to measure in a positive direction the water which goes through it, regardless of the direction of flow. Consequently, the water which fed from the higher to the lower reservoir was measured on each of the two Venturi meters, although as a matter of fact, it was never used in the distribution system at all. When the Venturi meters were originally installed the city was on a flat rate basis, and the waste of water was so large that it is doubtful if the water ever backed up into the lower reservoir. But with the metering of all the services the amount of waste gradually fell off until the condition prevailed of which I have just spoken.

Whenever a water system is fed by gravity from two or more reservoirs on different levels, it is well to grow immediately suspicious of back-feeding when the supply in the lower reservoir holds up better than the supply in the upper one.

Incorrect Meter Reading.—Another very interesting case was that of a small suburban city which purchased water from its larger neighbor by meter. As the city was being paid on its meters for less than half the water entering the distribution system, the water department had accummulated a large deficit. In addition to the conditions usually found by a survey, it was discovered that two 4-in. and two 6-in. meters were being incorrectly read, and that the city was being paid for only 10 per cent of the water going through them. The value of the water which had passed through the meters, but which had never been paid for, was nearly equal to the deficit of the department. An effort was made to collect this money on the grounds that the bills rendered the consumer bore the meter-readings and his acceptance and payment of the bills constituted an acceptance of the correctness of the meter-readings. As the department did not use a step rate, the matter of billing was comparatively simple. It is to be regretted that we cannot advise you as to the outcome of this attempt to collect, as we left the city before any settlements were made. Two of the consumers had, however expressed a willingness to pay; and I understand that the state commission had ruled that any failure on the part of the city to collect the full amount would be equivalent to the granting of preferential rates and would therefore be contrary to law.

This under-reading was caused by the fact that the smallest dial on the meters involved was graduated in units of one hundred, whereas the smallest dial on

all other meters on the system was graduated in units of ten. The meter-reader entirely overlooked the necessity of investigating the meter to determine in what units it was graduated.

How to Prevent Inaccurate Meter Reading.—That this is not the only case of its kind is shown by the fact that another similar condition was recently found. As a remedy for this it is suggested that meter-readers be not permitted to take their previous readings on a meter into the field and so help to carry the error through. It is further suggested that the office clerks be forbidden to change any readings in order to make them conform to previous readings. Wherever a doubt exists as to the accuracy of the reading on a large meter, it would be well to have it checked by the meter company's representative.

In another suburban city, which also purchased its water through a meter, periodically the receipts from the water department would drop below the cost of its water. The trouble in this case lay in a compound meter to a steel mill. The high duty side of this meter was dead; and whenever business was sufficiently good with the steel company to cause a draught of water large enough to throw the flow onto the high duty side of the meter, business was very bad with the water department. Another factory in a different part of the city had been suspected of stealing the water, which is probably the one reason why the real cause of this lost water was not discovered before.

In the same place the larger city had metered two services, and had for years been collecting revenue from them, when, in reality, the services were attached to the mains of the smaller town. Both cities had mains in this one street. In this case, all moneys that had been so collected were turned over to the smaller town.

The Source of the Spring. — In another suburban borough which purchased water by meter, the newspapers stated that the leak discovered by the survey had been running for twenty-five years and had cost the borough in that time a quarter of a million dollars. This is not of particular interest here, except as it lends point to another statement made by the same news article. It seems that, when a large sewer was laid past this leak, it was impossible to handle the water with a pump. It was decided that a spring had been tapped and special foundations were put in to protect the sewer. It should be noted here that the leak was from the open end of an abandoned service of which the borough had no record. In view of the known heavy losses, it is certain that the leak would have been discovered when this sewer was laid, had the water come from the direction of the main and not from the direction of a vacant lot.

It is remarkable how many springs, and swamps even, dry up after leaks on the water system are repaired. And how many people lose their source of valuable medicinal water.

Unauthorized Uses of Water.—Several years ago, when the stock of privately owned water companies was more or less a drug on the market, and few companies had paid dividends in many, many years, we caused considerable consternation on the part of the president of one company where we were working. It developed that a certain manufacturing company in the city was getting about 100,000 gal. of water a day free, through a defective meter. The president of the water company was also president of this factory. It was bad enough, he felt, not to get any dividends on his water company stock, without having the dividends of his factory cut into by increased water bills.

In another case we were called in to locate the cause of a large amount of water escaping from the high pressure system of a middle sized city. By a quirk of fate, it was discovered that 300,000 gal. per day of water were being surreptitiously taken from the system by a plant which was largely the property of the water commissioner. And he was the man who had been most instrumental in securing the commission for us in the first place. Certain it was that this water was being taken without his knowledge.

As a matter of fact, we find it generally true that, where water is being taken in an unauthorized manner, it is done without the knowledge or consent of the higher officials of the companies. It is usually some department head who wants to take a short cut to a good showing for his department.

Low Pump Discharges.—In recent years there has been a rapid increase in the development of electric power, with the result that many water plants have found it economical to substitute electrically driven centrifugal pumps for the old steam plant. Unfortunately, a full realization of the limitations of this type of pumping unit does not seem to have accompanied its installation. In only too many cases the only requirement placed on the pump is that it pump water. No apparent consideration is given to the efficiency with which this work is done. The displacement type of pump allowed so much latitude in operating conditions that many plant operators have not yet come to a full realization that centrifugal pumps operate efficiently only under the design head, and at the design rate of discharge.

No branch of work being done by our firm is more interesting than the efficiency tests on electrically driven centrifugal pumps. In one instance the pumping units were two 2,500,000-gal. pumps, working in parallel to give a combined output of 5,000,000 gal. per day. These pumps were designed to work against a head of 100 lb. The time came when these pumps would not carry the maximum day load. So the output was increased by putting the discharge of these two pumps through a 5,000,000-gal. pump designed to pump against a head of 50 lb. This gave, then, an installation designed to pump 5,000,000 gal. against a head of 150 lb., whereas it was working against a head of only 100 lb. This gave an increased rate of discharge, but at a considerable cost in efficiency. This was not the sole reason why the wire to water efficiency of the installation was under 44 per cent, as several pieces of wood were later taken from the ports of one of the pumps, but it did have a very important bearing on the loss of efficiency. It is of interest to add that, after disconnecting the 50-lb. pump from the discharge of the 2,500,000-gal. pumps, and cleaning these latter out thoroughly, a subsequent test on these two pumps gave an over-all wire to water efficiency in excess of 70 per cent.

In another instance the clear well was of such small size that it was necessary to coordinate the flow from the filters into the clear well with the pumpage out of it. As the low lift pump from the river to the filters had a higher rate of discharge than had the pump from the clear well to the distribution system, this coordination between the two pumps was secured by partially closing a valve on the discharge of the low lift pump. This increased the head at the pump above its design head and induced a slip into it. So much was this increase in head and slip that the power required to pump the reduced flow was much more than would have been required to pump the greater quantity for which it had been designed, had it been operating under design conditions. Throttled down, the pump had an over-all efficiency of approximately 30 per cent. A new low lift installation designed for a discharge equal to that of the high lift pump, thereby eliminating the necessity for throttling, gave on test, an over-all efficiency of approximately 60 per cent.

Another city had been computing its pumpage on a false pump rating, a rating in fact about double the pump's actual capacity. This pump rating was so much in error that, had it been correct, the installation would have had a wire to water efficiency in excess of 100 per cent. And the secret of perpetual motion would at last have been found.

These cases are called to your attention in order to emphasize the necessity for the services of a reputable engineer when this type of installation is contemplated. With the decreasing cost of electricity, this installation is becoming increasingly popular. The efficiency of electrical units should be closedly watched. The greater efficiency being obtained from modern units will often be sufficient to warrant the installation of new equipment.

The speaker recalls one instance

where the replacement of an old installation having an over-all efficiency of 57 per cent with a modern unit having an over-all efficiency of 72 per cent decreased each monthly power bill an amount equal to 5 per cent of the total cost of the new installation.

Then there was the centrifugal pump whose 10-in. discharge line was reduced to 6 in. for a few lengths of pipe. The explanation given for this novel procedure was that the water pressure would be increased after going through the smaller pipe. This reasoning sounds strange to us today, but one of our engineers, delving through the council records of a city where he was working, found a case equally interesting.

When Hydraulic Knowledge Was Limited.—Some sixty years ago when our knowledge of hydraulics was not as extensive as it is today, an engineer had been employed to design a main between the reservoir and the city. This main was partly 20 in. and partly 18 in., fed by a 12 in. from the reservoir. The engineer in charge of the work was the author of the following interesting explanation:

This main line of pipe was enlarged by the direction of the Committee on Water under the light head at the Westerly end, to render the same much more effective as a means of conveying and delivering water at the extreme end of the pipe here in the city. Since the lighter the head, the larger is the required diameter of the pipes necessary to furnish the amount of water conveyed by the small pipe under a much greater increase of head; this change has been one of much utility in increasing the efficiency of this supply main.

Within ten years after the main was put in service, the supply in the city became so deficient that the main was not full at all times. The report of the Water Committee says:

While the discussion was going on about the High Service, the Engineer discovered that the main pipe already laid was wrong end first, and that the advantages of having a small pipe near the reservoir to fill and supply a larger one in the city, were not so great as he at first supposed.

These are only a small part of the interesting conditions found in our 30 years' work.

Acknowledgment.—The foregoing is a paper presented at the last annual meeting of the Central States Section of the American Water Works Association.

Master Regional Plan for Philadelphia.—A purse of $500,000 has been raised by the Regional Planning Federation of Philadelphia to be spent in the next five years in the development of a master regional plan for the city and its environs.

Snow Removal in a City of 25,000

Beloit, Wis., Disposes of Snow Through Storm Sewers

By C. O. RICKSECKER
Superintendent of Streets

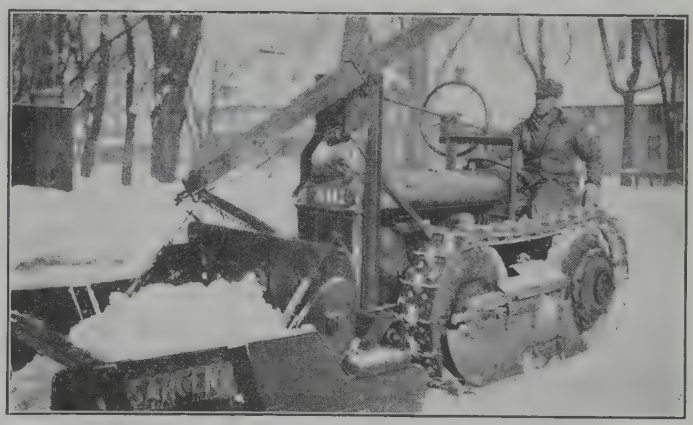
THE present administration of the city of Beliot, Wis., believes that it pays to keep the roadways of the business section free from snow and ice. Accordingly, city officials have carried out a policy of removing accumulated snow as rapidly as possible, and the most efficient methods of disposal have been sought to permit of securing the results desired.

Beloit is a city of about 25,000 population, having about 60 per cent of its roadways paved. The business section is divided by the Rock River, which conveniently allows large storm sewers to be brought under the downtown thoroughfares. A bridge with two trap doors over the river channel is centrally located. Thirty-three-inch manhole covers are placed on storm sewer manholes at favorable locations.

Disposal Through Manholes or Bridge Traps.—If a heavy snow is falling rapidly, it is plowed towards the curb to keep the roadway open until the storm is over. A motor patrol is then put on the streets to bring the snow back into the roadway in windrows not too large to handle. A truck or tractor then draws a snow scoop into the windrow of snow, where the scoop is loaded by one man. The loaded scoop is drawn to the nearest manhole or bridge trap and dumped as it is being drawn over the opening. The winter of 1928-29 was the first that motor power was used to draw the snow scoops.

If a snow is not falling too rapidly, the snow is plowed into windrows and moved away without first plowing towards the curb. A light snow may be moved from the curb into the roadway during the early morning hours, permitting automobiles to park normally while the snow removal is carried on during the day.

In disposing of snow through the storm sewer manhole, it is necessary to use a stream of water to carry the snow away. This is done by threading a fire hose through the storm water intake lateral and attaching it to a fire hydrant. This operation can be simplified by laying a small sewer pipe from the fire hydrant into the manhole at a time when new pavement is being laid; then only a short length of hose is needed to convey the water from the hydrant to the intake at the near end of the small pipe.



Motorized Equipment Keeps 80 Miles of Streets in Beloit, Wis., Open for Traffic During the Winter Months

Equipment.—One or two motor-powered road graders are used for keeping the snow in windrows. From four to six snow scoops drawn by one-ton trucks or Fordson tractors are sufficient if the haul is limited to two city blocks. The snow scoop used is the old-fashioned wooden scraper that has been in use for many years by ice harvesters—usually drawn by teams of horses. We are finding these wooden scoops rather light to be drawn by motor power and feel that there is room for improvement in this equipment.

In the residental sections, Beloit uses motor trucks fitted with mouldboard type snow plows. At this time the city owns two 5-ton street flushers that are snow-plow equipped in winter. An arrangement is made with a local contractor whereby the city furnishes the snow plows to equip his two 5-ton Mack trucks, thus making available four snow plows that are kept on the move during a storm to keep about 80 miles of streets open for traffic.

Adjustable Vanes on Turbine Runners.—Turbine runners at the Chippewa Falls plant of the Northern States Power Company in Wisconsin are equipped with adjustable vanes, the angle of which can be adapted to meet varying water conditions.

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Should Engineers Study the "Humanities"?

At the recent dedication of Dabney Hall, "the hall of humanities," at the California Institute of Technology, Dr. William B. Munroe said: "There is no good reason why engineers should be more limited in their intellectual versatility or in the range of their human interests than men in any other profession.

"These (humanity) courses cover the field of English and foreign literature, history, philosophy and social ethics, economics and government. No man can master science if he sets out to master science only. The history of human achievement has but a single page."

While we are believers in the thorough teaching of English and economics in all engineering colleges, we question the inclusion of the other subjects mentioned by Dr. Munroe, and we question even more seriously his whole attitude toward science.

Philosophy? What is it all about? The editor has studied at least three dozen books on the subject, and with the exception of those by Herbert Spencer, they constitute, for the most part, a very peculiar melange. In a recent editorial article entitled "Is Philosophy a Branch of Science?" we expressed the opinion that philosophy is a mixture of ultra-science (and therefore no science), metaphysics, morality and religion. We used Durant's "Story of Philosophy," and his definition, or rather description, of philosophy, to illustrate our meaning. He virtually admits the impossibility of defining philosophy, and by that very admission indicates the confusion that pervades that alleged realm of knowledge. Durant says: "Science gives us knowledge, but only philosophy can give us wisdom." This sounds erudite enough, but it is marrow of the very bone of nonsense.

The typical professional "philosopher" is a pathetic creature. He often starts by attempting to fathom the unfathomable. Failing, he still has the temerity to say that science lacks wisdom. We have been unable to find a single great discovery of any "philosopher" that has stood the test of time. Of course, many a truth has been uttered by "philosophers," but they were old truths and usually among the most obvious. Spencer came nearer to discovery of a great truth than any of them. But Spencer's philosophy is primarily a broad treatment of one scientific principle which he did not discover, namely, evolution.

Of all the subjects classed among the "humanities," history teaches the least, if you read it as it is taught. History falls even below philosophy in utility, for philosophy may at least set you thinking.

A teacher of history once asked an engineer whether he would not be ashamed not to know the main events of world history. The engineer replied by asking the teacher what causes typhoid fever; and received an admission of ignorance. Then the engineer asked: Which is most worth knowing; the campaigns of Caesar, or how to eliminate typhoid fever?

Typhoid at that time was one of our greatest scourges. Now it has practically vanished in America. Nothing but ignorance has so long delayed its banishment as a disease, but that was a kind of ignorance of which the typical teacher of history was not ashamed. He prided himself on knowing the chronology of kingly events and wars, but he took no pride in knowing how to reduce the death rate in his own town.

Still, it may be argued that when an engineer associates with "cultured" men, he must feel beneath their level if he can not talk about belles-lettres, history and the like. Any such argument shows that the proponent of "the humanities" little understands the culture of science. Was ever a true scientist abashed in making a confession of ignorance? Quite the contrary, for he knows that the all that any man knows is but the filmsiest gossamer beside the vast bulk of the unknown.

Men learn things, (1) for utility, (2) for the mere pleasure of learning, and (3) to secure the admiration that the learned are supposed to inspire; often the last named motive ranks highest. To be able to talk a learned jargon about art, about literature, about the Rome that was before her fall—such is the object of many a man, or at least it used to be a very common object a generation or two ago, when, as Spencer said: "Men dress their children's minds as they dress their bodies, in the prevailing fashion."

William Allen White, one of the speakers at the dedication of Dabney Hall, spoke of the advantage that "Cal. Tech." enjoys by reason of its proximity to "the store of research material at the Huntington library." That "store of research material" is mythical, we believe, in so far as utility is concerned; for it consists mainly of early editions and manuscripts of works that have no great value save that that springs from rarity. Like an indefatigable collector of postage stamps, the late Henry Huntington gathered into this library an amazing mass of literary junk. Grant that many an idle eye may gleam with passing interest over a manuscript poem of Burns or of Poe, and that many a tongue will tell how its possessor saw the first Guttenberg Bible in the Huntington library. There is just as much true worth, and not a tittle more, in such displays as there is in any other collection of antiques that give a thrill to the beholder. We do not deny the desirability of such thrills. We have often enjoyed wandering through such exhibits, and have gladly paid much money to reach them. The point we now wish to make is that the Huntington Library is infinitely less needed by the students and the teachers who work so near its portals than is a great scientific library, comparable, say, with the John Crerar Library of Chicago. The present library of "Cal. Tech." is almost an Eliot 5-ft. bookshelf compared with such a library as such a technical college should have.

Huntington followed his hobby of collecting objects of art and literature, and he poured millions into it. Yet within a rifle-shot and unobserved, there was springing up an institution of scientific culture destined

to make all his collections look as insignificant as the store of nuts gathered by a squirrel.

Huntington apparently had no conception of science, of its beauty and its power, of its culture and its grace, of its research devotees whose imagination outsoars that of the poets.

Einstein working in a garret, locked away from intrusion behind his iron door, was ten years dreaming a greater dream than can be found in all the tomes and manuscripts of the Huntington Library. But it will take more than a generation yet, we fear, before many of our men of great wealth will endow libraries for the use of the scientific dreamers who make their dreams come true. Theirs are the dreams that have lifted humanity above the level of a bestial struggle for existence; for upon an understanding of nature and her laws rests all of engineering and all of that great branch of engineering called invention.

Whenever an advocate of "the humanities" insists that engineering colleges should teach all the so-called "humanities," we rise to demur. With much better array of evidence might we argue that the sciences be given precedence in the courses that lead to an A. B. degree. But the truth is that it is futile to try to be jack-of-all-trades. After graduation many an engineer has beguiled his leisure hours reading history and literature of all sorts, and has puckered his brows over philosophies. Perhaps it has taken the typical engineer many a perplexed moon before it began to dawn upon him that his inability to see to the bottom of these philosophic wells lies not in the profundity of the depth into which he peers, but in the roiled and muddy water with which these wells are filled. If so, that type of reading is ill suited for an undergraduate, be he scientific or be he classical.

After all, a truly cultural course of study is one that trains a youth to become a systematic searcher for information and a good analyst of the significance of facts. When this is made the aim of formal education, less will be heard as to which particular class of facts should be studied. Even history might yield a splendid training in science if taught as research science is taught.

"The Padre of the Rains"

In a quiet little California town; and within the still more quiet confines of the walls of a Catholic university, lives a man whose research work is destined to rank with that of a brother Jesuit, long dead yet but recently become famous. The living man is Father Jerome S. Ricard, "the padre of the rains." The dead man is Gregor Mendel, great discoverer of the law of heredity that bears his name.

A few months ago the editor had the pleasure of interviewing Father Ricard in Santa Clara, and of hearing from his lips an account of his methods of weather forecasting. Since his methods have been described in this magazine, they need not be repeated now further than to say that Father Ricard bases his predictions upon the barometric effects of sunspots. At the first of each month he publishes his predictions for the following 30 days, covering only the weather of the Pacific Coast region.

Each sunspot in the sun's northern hemisphere tends to produce air-whirls on the earth, and if the spot is sufficiently powerful the resulting air-whirls develop into cyclonic storms. Solar rotation brings the same spot around every 27.28 days, as long as the spot "lives," and it is this fact that enables Father Ricard to predict the arrival of barometric "lows" on the Pacific Coast with such accuracy. Whether a rain storm will result from a "low," and exactly what the track of the storm will be, are matters not so certainly predictable; but from interviews with several persons who have kept records of the predictions and the results, it was found that Father Ricard's forecasts have been remarkably correct. Father Ricard said: "Sunspots do for the weather what the moon does for the tides and do it more visibly and more accurately."

Scientists have been so skeptical of the effect of sunspots on weather that they have seldom investigated thoroughly the evidence of that cause-effect relation. And where investigation has been made, it has usually resulted in doubt, because of the seeming complexity of the whole matter. But complexity is often more apparent than real, as the history of science repeatedly shows. Let even one important fact be unknown, and lack of knowledge of that fact may so obscure the entire phenomenon as to give an appearance of great complexity. One of the facts that has been insufficiently attended to, even when it was known (which was seldom), is the fact that sunspots in the sun's northern hemisphere produce exactly the opposite effect on our atmosphere that is produced by spots in the sun's southern hemisphere. Also there should be considered the fact that at about the middle of every 11.2-year sunspot cycle, the new sunspots have a rotation the reverse of that of the old sunspots, and consequently a changed magnetic polarity. In addition to these differences and changes, there is another factor that has received scant attention, namely, the periodic shifting of the latitude of storm tracks. The editor has found that there are 12 giant air whirl-belts, three of which have centers on the arctic circle; and that the cyclonic storms that come out of the north start in these whirl-belts, and travel in parabolic paths southeastwardly. When these giant whirl-belts expand, as they do when sunspots grow more numerous, the cyclonic storms originate in lower latitudes; but, tending to offset that, is the fact that the parabolic path flattens so that the storm center hugs closer to the giant whirl-belt. This usually causes a northward migration of the storm belts, a fact that had been previously discovered, but not explained, by Kullmer.

In one sense the whole problem of storms is complex; in another sense it is not. There are, it is true, several forces to be considered, and that gives it such complexity as it has. But, there is, the editor believes, only one kind of force, namely, electricity, that produces the major effects; and that fact gives to the weather problem a degree of simplicity not hitherto recognized. At any rate, this electrical "key" has already unlocked several doors of meteorological mystery and has made simple what before seemed complex.

In honor of Father Ricard's achievements, the Father Ricard Memorial Observatory has just been built at the University of Santa Clara, where he has taught astronomy and mathematics for many years. The observatory has a 60-in. reflecting telescope. Equipped with this new engine of research, greater knowledge of the relation of sunspots to weather will doubtless be made by "the padre of the rains" and his assistants. But we venture to say that the greatest engine of research in that observatory will continue to be the brain of the man to whom the observatory has been dedicated.

H. P. Gillette

New Books

"Memoirs and Addresses of Two Decades," by J. A. L. Waddell, Consulting Engineer. First edition, 1174 pages, 6 in. by 9 in., hard cover, cloth binding; Mack Printing Company, Easton, Pa., publishers. Edited by Frank W. Skinner, Consulting Engineer. Price, $5.00.

The material in this book is divided into eleven groups as follows:

1—The Engineer Profession, 2—Ethics of Engineering, 3—Technical Education, 4—Engineering Literature, 5—Alloy Steels for Bridge Construction, 6—Economics, 7—Bridge Construction in General, 8—Contracts, 9—Railroad Subjects, 10—Matters Chinese, 11—Miscellaneous Topics.

The great variety of subjects covered by Dr. Waddell during the last 22 years precludes any possibility of confining the material to one subject. It thus becomes necessary to classify his writings in a general way.

It is an outstanding characteristic of Dr. Waddell's professional work to reduce his thoughts to writing after he has completed some particular investigation or project. It is indelibly written upon his mind that transmission of knowledge, ideas and intelligence is one of the greatest forces promoting the advancement not only of our profession, but of the civilized world in general. He, therefore, responded to an irresistible inner urge that took the aspect of a duty, throughout his professional career to open his thoughts and results to the glare of public scrutiny and searching professional sifting.

This book is a compilation of the results of that urge. It should be very suggestive and helpful to all engineers who expect to design or construct important work. The civil engineer in general practice will find in the different pages presented here a broad and practical system; a code of high professional standards; a guide to fundamental technical education; and the epitome of bridge-design essentials which is today the highest standard for advanced construction and practical economics, and which furnishes data for the rational tests, estimates, and comparisons of different important designs.

"The Profession of Engineering," edited by D. C. Jackson, Jr., S. M., Professor of Mechanical and Electrical Engineering, University of Louisville, and W. P. Jones, Ph. D., Assistant Professor of English, University of Louisville. First edition, 124 pages, 5 in. by 7½ in., flexible binding; John Wiley & Sons, Inc., New York, publishers. Price, $1.50.

The articles in this volume, though written by several different men, were selected and arranged to form a unified whole. They give a broad, non-technical, yet detailed conception of the profession of engineering. The following articles are included: The Engineer and His Education, Success in the Engineering Profession, Civil Engineering, Mechanical Engineering, Mining Engineering, Electrical Engineering, The Electrical Engineer, The Chemical Engineer, The Engineer's Contribution to Modern Life.

"Sewerage and Sewage Treatment," by Harold E. Babbitt, M. S., Professor of Sanitary Engineering, University of Illinois, Member American Society of Civil Engineers. Third edition, 545 pages, 6 in. by 9 in., hard cover, cloth binding; John Wiley and Sons, Inc., New York City, publishers. Price, $5.00.

The continued advance through which the art of sewage treatment is progressing made necessary the revision and enlargement of this book. New additions to this text discuss information on the mechanical aeration of activated sludge, on gas collection from sludge digestion tanks, and on separate sludge digestion. In the first part of the book minor revisions have included simplification of methods of computation as in the design of an inverted siphon; correction of numerical solution of illustrative problems; and bring other information up to date.

The book is profusely illustrated and doubtful points clarified by picture or table. It is written more for the purpose of explaining fundamentals than of comparing various methods. The quotation of expert opinions which may be in controversy or the citation of examples of different methods of accomplishing the same thing has been avoided when possible in order to simplify explanations and to avoid confusing the beginner.

"Suspension Bridges," by D. B. Steinman, A. M. C. E., Ph. D., Consulting Engineer, etc. Second edition, 299 pages, 5¾ in. by 9 in., hard cover, cloth binding. John Wiley and Sons, Inc., New York, publishers. Price, $5.00 net.

During the past few years there have been new developments in the art of suspension bridge design and erection. Among the portions of this book that have been rewritten or amplified are those bearing on the topics of wire cables vs. eye-bars, rocker towers, anchorage design, materials used in suspension bridges, economics and limiting proportions, comments on the deflection theory, formulas for temperature stresses, multiple span bridges, proportioning cable bands, calculation of cable diameter, and time records of erection.

Appendix D, on the deflection theory, is perhaps the most important contribution to this new edition.

Appendix E presents an interesting chronological table of suspension bridges.

"The New Technique of Uncovering Security Bargains," by John Durand. First edition, 203 pages, 5 in. by 7¼ in., flexible binding. The Ticker Publishing Co., New York City, publishers.

This volume is intended to meet the requirements of month-to-month investors, where methods of operation occupy a middle ground between deductions from the technical position to which week-to-week traders look for guidance, and studies of values of fundamentals which are the chief reliance of year-to-year investors. The Group Ratio Curve, a tool developed for this purpose, is explained in this volume.

"Sewerage," by A. Prescott Folwell, Sc. D., Member American Society of Civil Engineers, Past President American Society for Municipal Improvements, Editor of Public Works. Tenth edition, rewritten and reset, 399 pages, 6 in. by 9 in., hard cover, cloth binding; John Wiley and Sons, Inc., New York, publishers. Price, $4.50 net.

Research and experiment, statistical analyses with records and operating experience, investigation and new equipment are some of the causes producing improvements and changes in not only the sewerage field but in all fields. This book has been rewritten to cover improvements and changes in the methods of handling sewerage. Progress in methods of sewerage disposal are largely responsible for the production of this book.

As in older editions, Part I concerns sewerage systems and Part II deals with sewage disposal. Beginnings have been made of thorough scientific studies of the biological, chemical, and physical phases of sewage treatment, with special attention to sludge digestion. A number of activated sludge plants have been built. More definite knowledge has been acquired concerning the effects of dilution and the principles involved therein. Inventions of machinery and equipment for treatment plants have come into extensive use. These are the primary causes for this revision.

The book is quite well illustrated.

"Mathematical Tables and Formulas," by Percy F. Smith, Ph. D. and William R. Longley, Ph. D., professors of mathematics in Yale University. First edition, 66 pages, 5¼ in. by 7¾ in., flexible binding; John Wiley and Sons, Inc., New York, publishers. Price, $1.60.

This collection of tables and formulas can be used handily for solving numerical problems of mathematical nature. They are only as accurate as the authors deemed commensurate with that required for practical work. Four figure accuracy was considered usually sufficient. The book should prove of some assistance to students in connection with college courses in trigonometry, analytic geometry, calculus, and mechanics.

"American Sewerage Practice, Volume 1, Design of Sewers," by Leonard Metcalf and Harrison P. Eddy, consulting engineers, Boston, Mass. Second edition, 759 pages, 6 in. by 9 in., hard cover, cloth binding; McGraw-Hill Book Co., Inc., New York, publishers. Price, $7.00.

This volume is primarily a reference book. It is the first of a series of three books by the same authors. American practice in sewer design has attained a certain degree of uniformity and considerable advance has been made in the methods of application of principles in recent years.

Table of contents:

The Lessons Taught by Early Sewerage Works; The General Arrangement of Sewerage Systems; Hydraulics—Flow of Water and Sewage; Velocities and Grades; Measurement of Flowing Water; Quantity of Sewage; Separate Sewers; Precipitation; Storm Water Runoff; Storm Drains and Combined Sewers; Gaging Storm Water Flow in Sewers; Sewer Pipe; Masonry Sewers; Loads on Sewers; The Analysis of Stresses in Sewer Sections; Inlets, Catch Basins and Manholes; Junctions, Siphons, Bridges, and Flushing Devices; Regulators, Overflows, Outlets, Tide Gates, and Ventilation; Pumps and Pumping Stations.

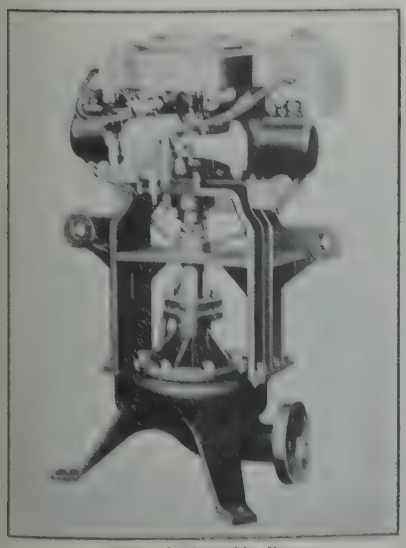
Evinrude Announces New Twin Centrifugal Pump

The new Evinrude pump, incorporating the features of portability, low cost operation, and large capacity, fills a definite need for contractors confronted with the problem of moving excess water from ditches and trenches, supplying pavers and mixers with water, and other everyday jobs. In commercial water transportation, this pump becomes very effective when awkward quarters, too small to handle a large diaphragm or bilge pump, often present a problem of excess water disposal. Dredging companies and barge lines are finding that the Evinrude centrifugal pump is a solution to their problem, for the outfit is portable and requires little space. When the Evinrude centrifugal is used, it is not necessary to start the motor merely to remove a small quantity of water.

This new improved centrifugal is powered by the Evinrude 6-hp. "Fleetwin" motor, a modern twin engine. Manufacturing precision is used in machining, and by carefully weighing and balancing all moving parts, a power plant which is practically vibrationless has been achieved. At the same time, the new pump has been decreased in weight to slightly over 100 lb., making the outfit truly portable and vastly increasing its field of usefulness.

Notwithstanding the fact that the pump is no larger than a small keg of nails, it is capable of pumping 15,000 gal. of water an hour and reaches a head of 50 ft. with ease, the manufacturer claims. The operating cost is negligible, not exceeding 15 ct. per hour, or 1 ct. per 1,000 gal., they state.

The pump itself has but one moving part, the bronze impeller, directly splined to the alloy steel shaft. When revolved, the flukes or vanes of the impeller throw the water outward with a great force and cause it to flow through the discharge pipe. The motor is fitted with the Evinrude magneto of the built-in flywheel type. The flywheel itself acts as an umbrella-like protection over the magneto, shielding it from rain, spray and dirt. Waterproof cables connect to the spark plugs. The Evinrude carburetor brings the advantage of automobile carburetion; a float-feed carburetor which works in any position. With capacity more than doubled over last year, and with the weight decreased 10 per cent, and over all size 11 per cent, the new Evinrude twin-cylinder vibrationless centrifugal pump makes a noteworthy addition to the portable pump field.



Evinrude Portable Pump

Long Handled Meter Key

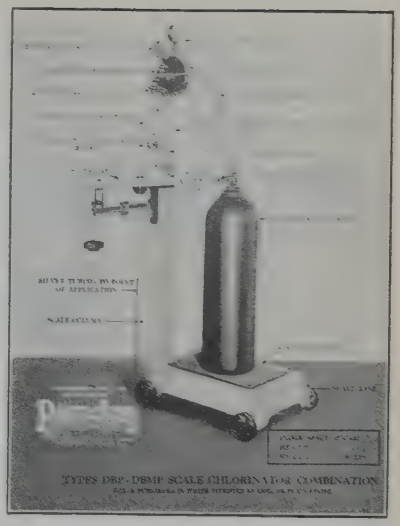
The H. W. Clark Company of Mattoon, Ill., have placed on the market a long handled key for operating their meter boxes. The box has been in production only a short time. It is 16 in. in diameter and 16 in. deep, with a full 12-in. lid opening. The lid is equipped with a rustproof lock, which is operated by the long handled key. A lug on the side of the key may be used to flip back the lid of the meter. The end is provided with a chisel point for scraping.

New Meter Box and Key

A New Combination Chlorinating Scales

The Paradon Manufacturing Co., Arlington, N. J., announces a combination chlorinator-platform scales, known as Model DRP chlorinating scales.

The complete chlorinator is directly mounted on a standard platform scales. The unit is designed so that all parts of the combined chlorinator-scales are interchangeable with the parts of the regular chlorinator without the scale mounting so that existing chlorinator installations may readily be converted to the new chlorinating scale type.



Paradon Scale Chlorinator Combination

The use of a platform scales in connection with a chlorinating installation has practically become standard practice among engineers and sanitarians.

Advantages claimed for the new chlorinating scales are that it saves considerable floor space, makes a neat and more attractive installation than where scales and chlorinator are separate, and that it insures the scales always being available for use with the chlorinator, and not for other uses about the plant.

The cost of the new chlorinating scales, using a standard platform scales, is no more than the cost of the chlorinator and scales separate.

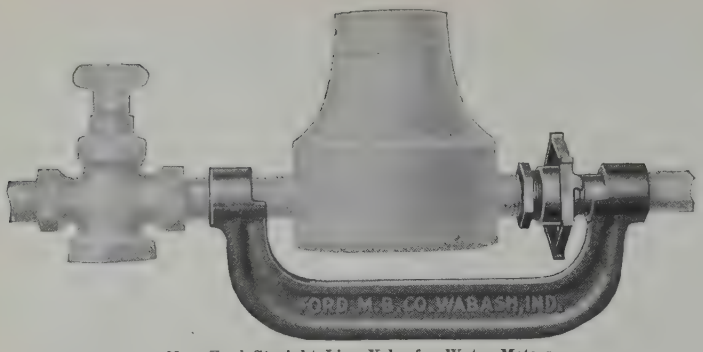
The combination is adaptable to all standard Paradon chlorinators—both solution feed and direct feed types—and for any chlorine capacity.

For further information write to Mr. R. V. Donnelly, Paradon Manufacturing Co., Arlington, N. J.

New Meter Box Yoke Developed

The Ford Meter Box Co., Wabash, Ind., has recently developed a new type of meter box yoke. They have called this new yoke the Straight Line yoke. It is intended primarily for water meter installations where the pipe and meter are set in a straight line through the meter box. Such settings are standard practice in the south and west, where the climate is mild and surface lines shallow. It is also well adapted for basement installations.

A water meter set in such a line with



New Ford Straight Line Yoke for Water Meters

ordinary couplings is very difficult in removal and replacement, as the gasket space is nearly always wrong, and the coupling nuts can hardly stretch the pipe to pull the coupling barrel tight against the meter gasket.

The Ford Straight Line yoke simply provides a strong spacer piece, or yoke, which becomes part of the straight run of pipe, and also provides an expansion connection which screws onto the meter and then expands outward against the gaskets in the yoke saddles to make tight joints. To remove the meter, the connection is contracted and the meter lifted out. The pipes never move and the spacing and alignment are permanently fixed.

The Straight Line yoke costs but little more than the couplings and fittings it replaces, and it gives many advantages. It is made with or without a union for old or new services, and for ⅝-in., ¾-in. and 1-in. meters.

More details may be obtained from Mr. John L. Ford, Ford Meter Box Co., Wabash, Ind.

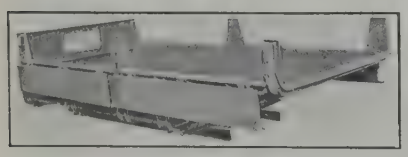
New Garbage Hauling Truck Body

The Wood Hydraulic Hoist & Body Company recently produced new special dump bodies for garbage collection to be used by the city of New York.

The type W-34 special garbage body has sliding steel covers—in four sections, with manually-operated tailgate. It is constructed of high carbon, blue annealed sheet steel—hot riveted and electrically welded for water tightness. Rear end is tapered 20 deg. to allow contents to flow freely when dumping.

The type W-36 is similar to the type W-34, except that it has hinged extension sideboards with patent tailgate which hinges underneath body when dumping, but no steel covers. Tarpaulin covers may be used.

Further information about these garbage bodies may be obtained from the manufacturer.



W-36 Body—Tailgate Hinged Underneath Body and Sides Hinged Downward for Easy Loading

Koehring Pull Shovel Announced

The Koehring heavy duty pull shovel is the latest unit added to the line of excavating equipment manufactured by the Koehring Co., Milwaukee, Wis.

The outstanding features are (1) the shock absorbing principle in the boom base and in the dipper stick and (2) a specially designed jib frame providing a greatly increased working range and flexibility of operation.

The boom shock absorber is identical with that used on the Koehring shovel and in the same manner takes the twisting strains out of the boom and cushions the dipper when trimming the sides of a sewer trench.

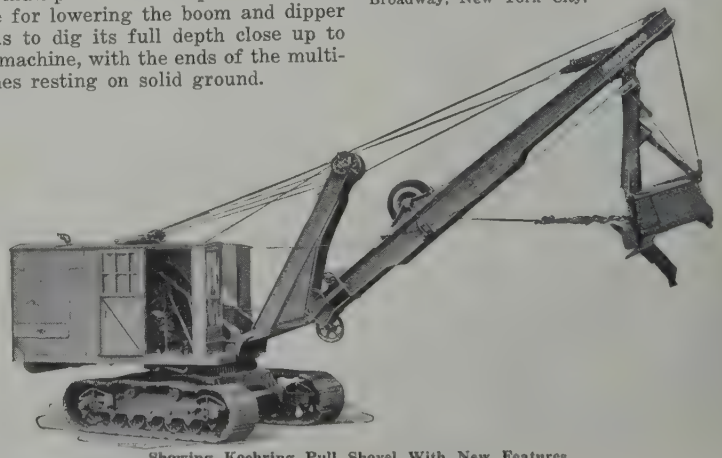
The dipper stick unit adds power to the digging effort by producing a gnawing action in hard, tough digging through the action of the powerful shock absorbing spring upon the dipper.

Instead of being hinged to the turntable casting, the boom is hinged to a separate casting which forms the base of the jib frame. The hinge point on all machines is 6 in. beyond the end of the multiplanes. This provides clearance for lowering the boom and dipper so as to dig its full depth close up to the machine, with the ends of the multiplanes resting on solid ground.

This hinge point can be raised to a working position from 1 ft. 9 in. to 2 ft. above the turntable hinge pin sockets, giving a high dumping clearance. Or, the hinge point may be lowered below the level of the turntable sockets to provide a maximum digging depth.

This construction of the jib frame gives the Koehring flexibility and variation of working range in all operations.

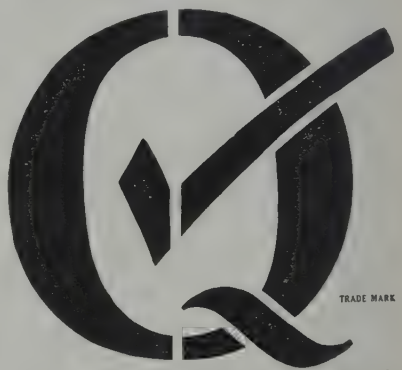
The Koehring pull shovel is built in two sizes, equipped with ⅞ and 1¼ cu. yd. dippers. Digging depths range from 17 ft. to 24 ft.



Showing Koehring Pull Shovel With New Features

Q-Check Distinctive Trade Mark

The symbol shown in the accompanying figure has been adopted as the trade mark of the Cast Iron Pipe Research Association. Cast iron pipe which has benefited through improvements which scientific research has introduced, can hereafter be identified by this symbol. It will appear on cast iron pipe made by the following pipe founders:



The Cast Iron Pipe Research Association's Trade Mark

American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe & Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Cast Iron Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

Municipal News and Water Works

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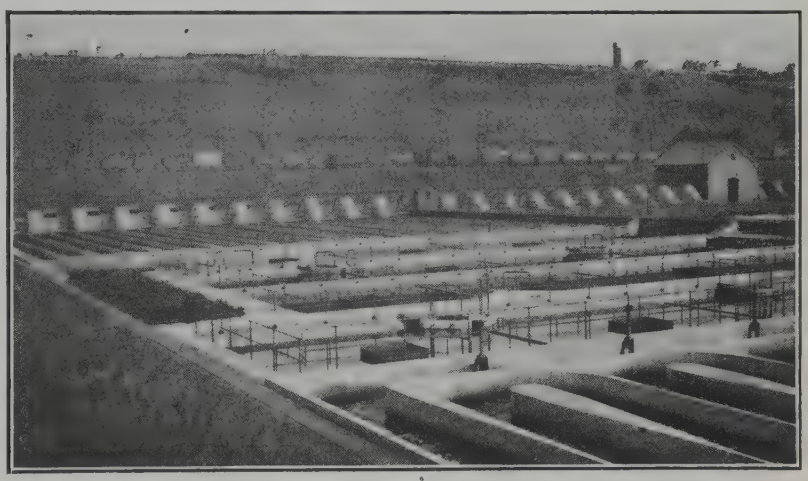
Activation of Sludge By Mechanical Aeration

Development of Mechanical Aeration, Application to Activated Sludge Plant, Described

By W. DEWITT VOSBURY and PHILIP B. STREANDER

THOROUGH aeration and agitation of sewage under treatment are fundamental requirements of the activated sludge process. With the exception of certain plants in England and a limited few in this country, compressed air always has been used to accomplish the purpose. However, there is now a growing tendency among engineers and others to consider the use of purely mechanical devices as distinguished from compressed air to produce the aeration and agitation required. It is the purpose of this paper, therefore, to discuss certain types of mechanical agitators which eventually may become of more or less common use.

However, to understand how mechanical agitation operates to produce the desired results, some knowledge of the activated sludge process is first necessary. A brief description of the underlying principles of this process will therefore be given.



General View of Present Sheffield, England, Plant. Haworth Paddles are Used

Activated Sludge Process.—The activated sludge process has been defined by the Sewerage and Sewage Disposal Committee of the Sanitary Section of the American Public Health Association as one which "consists in the agitation of a mixture of sewage with about 15 per cent or more of its volume of bacterially active liquid sludge in the presence of ample atmospheric oxygen; the agitation to continue for a sufficient period of time to at least accumulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aeration of successive portions of sewage and maintained in its active condition by adequate aeration by itself or in contact with sewage."

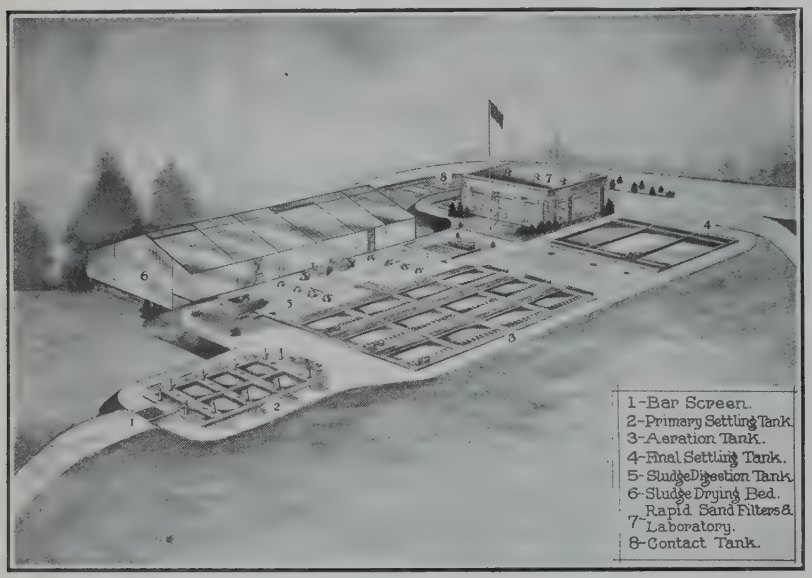
Birmingham, England, Plant, with Hartley Paddles

This definition, translated into terms of at least one type of working plant of moderate size and recent design, implies that ways and means must be provided for: first, elimination of grit, if any is present; second, separation of the coarse solids from the incoming sewage; third, aeration and agitation of the partly clarified sewage in the presence of sludge which has been previously activated; fourth, sedimentation of the aerated sewage; and fifth, disposal by digestion or otherwise of the coarse solids which were first taken from the incoming sewage, together with the surplus of activated sludge not needed for mixing with the sewage while it is being agitated and aerated.

In the operation of a plant of the type just outlined the raw sewage is first passed either through a fine screen or a pre-sedimentation tank, for the purpose of removing as much of the coarser solids as possible. It then enters the aeration tank, where it is mixed with from 10 to 25 per cent by volume of previously activated sludge and then agitated for a period of approximately 6 hours. The resultant mixture of sewage and sludge is then conducted to the final settling tank, where the floc which has been formed is removed by sedimentation and the clear liquid passed from the plant if the degree of

purification so far provided has been sufficient.

A part of the floc or activated sludge deposited in the final settling tank is returned to the aeration tank, where it is again brought into contact with the sewage which is being aerated. In continuous flow plants the cycle of mixing of activated sludge with fresh sewage, aerating and agitating the mixture, settling out the floc and returning a portion of it to the aeration tank is repeated over and over again.



Perspective Drawing of the Activated Sludge Plant Described in the Text. Capacity 600,000 Gal. Per Day; Designed for a Population of 6,000

The process which has thus been briefly outlined is one which is biochemical in nature. It is also similar to that which takes place in a plant where sprinkling filters are used. In the latter the sewage is brought into close contact with growths of oxidizing bacteria which form the bacterial slime on the surface filter media. In the activated sludge process, particles of sludge of similar composition are circulated through the sewage under treatment. Agitation is used to circulate and mix the fresh sewage with the activated sludge. Air is also required to furnish the atmospheric oxygen necessary to promote the growth of the oxidating bacteria. It will be seen, therefore, that both aeration and agitation are fundamentally necessary as a part of the process.

Use of Compressed Air.—In the past, compressed air has been most frequently used for the purpose, since when properly introduced into the liquid it will both agitate it and at the same time supply the oxygen required for aeration. Air is usually introduced into the tank through porous plates in the bottom. In some plants the plates are evenly distributed throughout the area to be aerated. In others the plates are arranged in rows at equal intervals crosswise of the tank so as to form air baffles consisting of curtains of ascending bubbles, through which the sewage must pass. Of late, there has been an increasing tendency to introduce the compressed air through plates located in rows at one side of the bottom of the tank. When this is done in rectangular tanks with proper longitudinal baffling the force exerted by the ascending air along only one side of the tank imparts a rotary motion to the sewage. This results in the sewage traveling in a spiral path from one end of the tank to the other, and the maintenance of a velocity sufficient to prevent settlement of sludge.

Like every other process, the use of compressed air is attended by certain disadvantages. Only a small portion, or about 7 per cent, of the air which is blown through sewage is used for oxidization. The remainder, or 93 per cent, serves only to produce agitation. To use air for this purpose is expensive, in view of low efficiency, relatively high cost of plant distribution system and the losses due to friction in the pipes and diffusers. In addition, the greatest care must be taken to prevent the clogging of the fine pores of the diffuser plates with atmospheric dust, oil from the compressors or rust from the air pipes. It likewise might be added that it cannot be considered desirable to have the essential parts of a plant always submerged in liquid and not easily accessible or usable when in operation.

Experiments in Mechanical Aeration.—In 1905, Adeney of England performed certain experiments which proved that while the surface of de-aerated water remained smooth, absorption of oxygen from the air was extremely slow, but that when the surface was kept gently broken the water was rapidly aerated. Later experiments made in 1921 by Haworth and Hodgkinson, two English engineers, led them to conclude that the surface of air bubbles was not especially suited to permit solution of oxygen from the bubble itself, and that the great change of surface produced at the top of the liquid by rising bubbles probably accounted for the large amount of the solution of oxygen obtained. This was evidently proven to their satisfaction, for they substituted bubbles of nitrogen gas for air and found that the absorption of oxygen into solution still took place. These experiments, with others of a biological nature, indicated that sewage could be successfully aerated by mechanical means as distinct from the use of compressed air.

The first large-scale plant employing mechanical agitation was placed in operation at Sheffield in 1920. The aeration tank had a capacity of about 355,000 British gallons daily. In size it was approximately 201 ft. long by 75 ft. wide, with a depth of 4 ft. It was subdivided into 18 chambers, each 4 ft. wide and with alternate ends connected so that the sewage traveled back and forth a distance of approximately three-quarters of a mile from inlet to outlet ends. Skeleton paddle wheels, one to each channel, on shafts extending across the tank at its center, were used to agitate and propel the sewage. By the action of the paddle wheels the sewage was caused to circulate continuously back and forth from one channel to another at a velocity of about 1.7 ft. per second. Thus the liquid was agitated and rapid surface changes were created. The purification obtained was considered generally satisfactory, as a well oxidized and non-putrescible effluent was produced.

Keeping Sludge in Suspension.—The reactions which occur in a tank of this type have been compared with those which take place in a flowing river, wherein sewage is received and purified by the natural processes at work. However, aeration of sewage in channels like that in a river has its difficulties. Activated sludge sinks at approximately the rate of one inch per minute. Thus, at a velocity of 1½ ft. per second, sewage will have traversed 90 ft. before the sludge has settled an inch. Therefore, linear velocity alone aids very little in keeping sludge in suspension.

In order to overcome the tendency of sludge to settle and at the same time to expose a greater surface for aeration, a spiral flow has been imparted to the liquid. This, as already explained, has been obtained in the case of tanks using compressed air by placing the diffusers to one side. In certain English plants, where the aeration tanks consist of long channels, there is in use what is termed a high-efficiency inclined paddle. One of these paddles is located at the U-bend or return end

of each channel. In action, it propels the sewage with high mechanical and hydraulic efficiency around the bend and along the channel. At intervals along each channel are placed straight, flat plates. They are virtually immersed in the liquid at an angle inclined to the flow. They produce a perfect rotary flow and permit a reduction of the linear velocity from 1.5 ft. per second to 0.5 ft. per second without tendency to settlement on the part of the sludge. It is reported that the process using this device and known as the Hartley spiral flow process, has been found to give results very nearly equal to that obtained with compressed air with the same period of contact and at only half the power.

There are now two types of mechanical aerators which are being introduced to American practice. One is known as the Simplex surface aerator and the other is the Link-Belt aerator.

Simplex Surface Aerator.—In his early experiments, Haworth used a vertical cylinder equipped with a propeller which could be rotated rapidly to induce circulation. The flow through the cylinder was downward, with the return flow taking place in the tank outside. Mr. Bolton, manager of the sewage works at Bury, and the Ames Crosta Engineering Co. developed a similar machine, but with an upward circulation. This machine is now known as the Simplex surface aerator. It consists of a stationary cylinder or uptake tube, 2 ft. 6 in. in diameter, with the exception of the bottom, where it is enlarged in the form of a cone. At the surface is a revolving disc, 5 ft. in diameter, fitted with vanes, designed to throw a thin upper and lower sheet of liquid across the surface of the tank. As the sewage which is being sprayed strikes the surface of the liquid in the tank, numerous air bubbles are formed. In addition, there is set up a downward circular motion of the sewage, which mixes the activated sludge with the incoming raw sewage. All liquid thrown out by the revolving cone comes through the uptake tube from the bottom of the tank, assuring positive circulation. The machine is usually installed in tanks 22 ft. square by about 15 ft. deep. Power consumption approximates 14 kwh. per million gallons of sewage treated.

There are a number of installations of Simplex aerators that are in operation and giving excellent results. So far it is the only mechanical aerator that has been adopted for use in this country.

Link-Belt Aerator.—The Link-Belt Co. of Philadelphia has recently developed a new type of aerator which offers much of promise. It produces the spiral form of circulation similar to that already described. It differs in practically no way from the "spiral flow process" as developed by Hurd at Indianapolis, with the exception that purely mechanical means are used instead of diffused air.

Agitation and circulation are produced by the action of a revolving, paddle-like element of small diameter, located at one side and extending the whole length of a tank. The blades of the paddle are in the form of a comparatively narrow, broken ribbon, pitched both ways. The center of the shaft that carries the paddle blades is located a few inches above the surface of the liquid at a distance of approximately 3 ft. from the side of the tank. The outside diameter of the cylindrical surface formed by the paddle blades when they revolve is about 26 in.

A vertical baffle wall is used to prevent short circuiting of liquid in circulation. This wall is placed parallel to and at a distance of 18 in. from the wall of the tank. It extends from a point a few inches above the surface of the water to within 18 in. of the bottom of the tank. A metal apron, curved to conform with the path of the paddles, extends from the baffle wall, underneath the rotating mechanism about two-thirds of the way to the surface of the water. Upon starting up the paddles the sewage is drawn over a weir located at the top of the baffle wall and forced across the tank on the surface at a velocity of approximately 2.5 ft. per second. Upon reaching the opposite side of the tank it meets a deflector, which directs it downward. It then sweeps across the bottom of the tank and rises up behind the baffle wall to meet the paddles again. It is in this manner that a spiral flow is created, which begins the moment the sewage enters the tank and does not cease until it leaves it. Thorough agitation and surface aeration are therefore accomplished.

The bottom velocity has been found by test to be a minimum of approximately 1.5 ft. per second, which is sufficient to prevent settlement or the accumulation of solids. Power consumption is estimated at 14 kwh. per million gallons of sewage treated.

Other Adaptations.—So far, the discussion on mechanical aeration has been in conjunction with activated sludge plants only. This discussion would not be complete without bringing up the possibilities of mechanical aeration as applied to existing plants having settling tanks for primary treatment and sprinkling filter beds for secondary treatment.

Link-Belt Mechanical Aerator at Maywood Plant of the Sanitary District of Chicago, in Operation. Capacity 52,400 Gal. Per Day; Detention Period Six Hours

The development of communities has, in numerous instances, been so great that the capacities of their sewage treatment plants have been reached and exceeded in much less than the estimated time. While the problem in these instances is entirely one of finances, the burden falls on the engineer, who must devise ways and means of overcoming the difficulty at the lowest possible cost, since in some instances a plant extension is required before the bonds covering the original plant have been retired.

Pre-aeration of settled sewage prior to its application to the sprinkling filter beds appears to offer at least a partial solution of this problem. By aerating the settled sewage for periods approximating one hour, the reduction in the b.o.d. of the settled sewage approximates 25 to 30 per cent. This reduction in b.o.d. is apparently due to the absorption of oxygen by numerous exposures to the air of the sewage.

Aeration partly accomplishes the biochemical decomposition of organic mat-

A Simplex Unit at Princeton in Operation

ter by the utilization of dissolved oxygen through bacterial activities on an aerobic basis and in effect accomplishes the same results as are obtained in the upper section of a sprinkling filter bed.

The amount of oxygen absorbed by surface aeration is a function of turbulence, area and time. Turbulence is obtained in mechanical aeration by the rapid breaking up and throwing of the sewage across the surface of the tank. Area and time would naturally be determined for each installation and would depend on the character of the settled sewage and the aeration required.

Some idea of the rapid exposure obtained with mechanical aeration can be had by considering a tank, say 15 ft. wide by 60 ft. long, at an average surface velocity of 2½ ft. per second. This would require 6 seconds to make a surface change, which would be equal to 10 per minute or 600 per hour. With a surface area of 15×60 or 900 sq. ft., this is equivalent to 540,000 sq. ft. or approximately 12 acres per hour, or 288 acres per day.

So far, several plants have considered this possibility and experiments conducted have proven that oxygen is absorbed by aeration. Therefore, aeration of the sewage between the settling tanks and the sprinkling filter beds should decrease the b.o.d. of the sewage as applied to the beds and should allow an increased loading on the beds by an amount approximately equal to the reduction obtained by aeration.

Application to Activated Sludge Plant.—It may be of interest to describe a treatment plant of the activated sludge type, using mechanical aeration. This plant is shown in perspective in an accompanying illustration and is now under contract for construction. As the effluent from the plant is discharged into a small brook an extremely high degree of treatment was required by the department of health for approval of the plans. In brief, it is anticipated that the final effluent will be colorless and clear and will have at least a 10-day stability and bacteria absent in 50 cc.

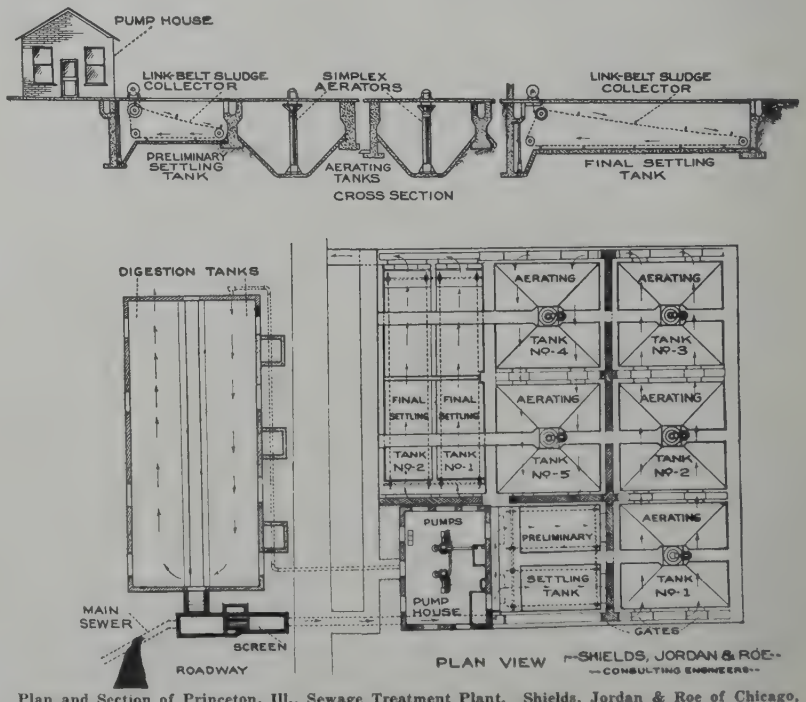
The plant is designed for a capacity of 600,000 gal. per day and a population of 6,000. Units of treatment consist of:

1. Preliminary clarification tank, having a detention period of one hour.
2. Aeration tanks having an aerating period of 6 hours, including 25 per cent return sludge.
3. Final settling tanks having a detention period of 1½ hours with 25 per cent returned sludge.
4. Rapid sand filters, operating at the rate of 1½ gal. per sq. ft. per minute.
5. Contact tank for sterilization, having a detention period of 30 minutes.
6. Sludge digestion tank based on 2.0 cu. ft. per capita with heating coils and gas collection.
7. Glass covered sludge drying beds.

The preliminary clarification tank is preceded by a bar screen and a sand trap. The tank is divided into two separate compartments having hoppered bottoms for the accumulation of settled sludge, the withdrawal of which is effected by sludge piping operating under a hydrostatic head of 4 ft. The effluent from the tank is discharged into a sewage diversion chamber, designed to divert equal volumes of sewage to each of the aeration tanks.

Mechanical Aeration.—The aeration tanks are divided into three separate compartments, each equipped with a Link-Belt aerator. Activated sludge return piping has been arranged so that the point of application can be varied, as it may prove to be decidedly beneficial to aerate the sewage prior to the application of activated sludge. The effluent from each compartment is discharged over weirs and piped to the final settling tanks.

The final settling tank is also divided into three separate compartments, each compartment being equipped with mechanical scrapers for the concentration of the settled sludge. The sludge is collected in hoppers located at the influent end of the tank and is removed through a vertical sludge pipe connected to a sludge channel. The upper part of this pipe has an adjustable section, which contains a V-notch weir over which the sludge is discharged. The



Plan and Section of Princeton, Ill., Sewage Treatment Plant. Shields, Jordan & Roe of Chicago, Consulting Engineers

position of this weir can be adjusted to meet almost any sludge return rate. The effluent from the tank spills over weirs and is piped to the rapid sand filter beds.

Rapid Sand Filters.—There are four rapid sand filters, each having an area of 70 sq. ft., giving a total area of 280 sq. ft. These rapid sand filters are identical with those used in a water works and are equipped with filter sand, graded gravel, manifold system, rate controllers, loss-of-head and rate-of-flow gauges, etc. An automatic closing-off device is provided to function during periods of low flow so as to prevent the level of the sewage from falling below the sand line. Washing of the filter is accomplished by a wash-water pump and the waste wash water is discharged into a reservoir placed under the filter beds, from which it is pumped out at a very slow rate and returned to the influent end of the plant. The filters are housed in a building which will also house the chlorinating apparatus, the air compressor units for sludge lifts, laboratory equipment, etc.

The effluent from the filters is chlorinated and piped to a contact tank, from which it discharges through the outfall sewer to the brook.

Sludge return from the final settling tank is effected by piping the sludge to a sump, in which is placed an air lift to lift the sludge into a sludge diversion chamber, from which it flows over three V-notch weirs, one for each compartment. It is then piped to the aeration tank and surplus sludge piped to the sludge digestion tank. Sludge from the clarification tanks is also piped to a compartment alongside the activated sludge sump and lifted up and discharged to the sludge digestion tank.

Sludge Digestion Tank.—The sludge digestion tank is divided into two separate compartments. Each compartment is divided into channels by baffles, placed so as to obtain a roundabout passage for the sludge. Raw sludge from the clarification tank and excess activated sludge are piped to the influent end of either compartment so that they are mixed as they enter the tank. Arrangements for seeding with digested sludge have been provided and consist of an air lift placed in the sludge discharge pipe, which lifts the sludge into a compartment from which it is piped to the influent end of the digestion tank. Digested sludge is discharged under a hydrostatic head of 4 ft. to a channel connected to each sludge drying bed. Supernatant liquor will be removed by means of a rotary type decanting valve designed so that liquor can be taken off at 6-in. depth intervals throughout the full depth of the tank.

Heating coils have been provided for each compartment, consisting of 1½-in. wrought pipe laid in the bottom of the channels. The entire tank will be practically gas tight and will be provided with gas domes to collect the gas. These are manifolded and piped to a gas-fired hot water boiler placed in a boiler room alongside of the sludge digestion tank. Pressure relief tank, condensation traps and fire traps, have been included with the boiler room equipment, together with gas and water meters, circulating pump, heat regulating apparatus, etc.

Glass Covered Drying Beds.—The sludge drying bed is of the glass covered type and is divided into six compartments. The beds are of the conventional type, consisting of 6 in. of sand supported on 9 in. of graded gravel. Each bed contains an open-joint underdrain piped to a main drain, which in turn discharges into the waste wash-water storage tank under the filter building. Drained liquor is pumped back to the influent end of the treatment plant.

Means have been provided for bypassing excess activated sludge during the summer months direct to the sludge drying beds, provided the direct drying of the sludge can be effected in this manner.

The cost of this plant, having a capacity of 600,000 gal. a day, was only $97,000.

Acknowledgment.—The foregoing paper was presented at the 14th annual meeting of the New Jersey Sewage Works Association, held on March 22 and 23 at Trenton.

Water Softening and Purification at Columbus, O.

During 1928 an average of 29.4 million gal. of water was softened and filtered by the Water Works of Columbus, O. This represents 98 gal. per capita per day. The following details of the work are taken from the report Charles P. Hoover, Chemist in charge:

Hardness of Water.—The hardness of the water was reduced from an average of 242 parts per million to an average of 86 parts per million. A reduction of 64 per cent.

Quantity of Chemicals Used and Their Cost.—To reduce the hardness of the water from an average of 242 parts per million to 86 parts per million, 2,673 tons of soda-ash and 7,991 tons of lime were required. The price paid for soda-ash was $27.74 per ton, and the price paid for lime was $6.52 per ton, making the total cost for soda-ash $74,149.02 and the total cost for lime $52,101.02. The cost of lime, soda-ash, alum and chlorine per one million gallons of water treated amounted to $13.67.

Turbidity and Color Removed.—The average turbidity or muddiness of the river water during the year was 108 parts per million, whereas the turbidity of the filtered water was zero. The average turbidity has been higher during the past three years than in former years. This is due to the O'Shaughnessy dam which holds back the flood water, causing the water coming to the plant to be muddier for longer periods of time. The average color present in the above water derived from decay of vegetation, was 23 parts per million. By the combined use of lime, soda-ash and alum, the color was reduced in the filtered water to one part per million. A color of one part per million is not noticeable to the consumer.

Typhoid Fever.—There were five deaths from typhoid fever during the year 1928, three of which were resident and two non-resident. Figuring the population at 299,000 (state bureau of vital statistics estimate) would give the city a total death rate from typhoid fever of 1.7 per 100,000, a resident death rate of 1.0 per 100,000 and a non-resident death rate of 0.7 per 100,000.

Recarbonation Plant.—The recarbonation plant has been operating successfully during the entire year.

For the past 19 years the alkalinity of the filtered water has averaged 55 P. p. m. During 1928 by the aid of recarbonation, it has been possible to reduce the average alkalinity of the filtered water to 43 P. p. m. For 19 years the average reduction of alkalinity has been 66 per cent as compared to 72 per cent during the past year. The filtered water has during the past 19 years carried caustic alkalinity or excess lime to the extent of 5 P. p. m. whereas, with recarbonation there has been no caustic alkalinity. Normal carbonates, which cause trouble due to formation of deposits on filter sand and in distribution pipes and meters, have been reduced to a figure which is well under its solubility limit.

Trouble with filter sand, through which the entire water supply is filtered, due to the grains cementing themselves together and forming hard lumps has we believe, been entirely eliminated. There has been great improvement in the operation of the condensers at the pumping station. In former years it required three days to clean a condenser. Now the job is easily done in one day. Further growth of deposits in the distribution system seems to have ceased. There has been a reduction in the number of meters clogged by carbonate deposits and the cleaning out of hot water coils has been reduced to a minimum.

Methods of Thawing Frozen Hydrant.—A study made recently by the New York State Bureau of Municipal Information, showed that 25 municipalities used steam for thawing frozen hydrants, 10 used electricity, 7 used a commercial hydrant thawing device and 5 used salt, carbide or other material. Two municipalities used alcohol in the hydrants to prevent freezing.

Factors In Cost of Water Mains

Methods Used in Practice and Design

By JAMES P. IRONS
Superintendent Water and Light Department, Topeka, Kan.

IT is my thought that this subject should be treated from the economic viewpoint rather than from the position of detailed costs of the different items involved in the construction of the various classes and types of water mains. With this idea in mind I will give consideration to the various methods used in the practice and design of water mains and their construction.

Too Much Paring Down Costs.—It has been my experience that in the administration of our public works, there has been too much of an effort made to pare down to the very minimum, the first cost of construction of all kinds. This is not done so much by engineers as by public officials in elective offices, who are more or less responsible to the mind of a fickle public, on the various amounts of money expended by them; whether it be for improvements and betterments, or simply for the administration of the various duties their offices may demand.

I have made these statements, not to give you the idea that we should indiscriminately raise the first cost of construction to the point where it is prohibitive; but rather that we should depend upon the recommendations of specialists and that we should also give careful thought to the methods, and their costs, that will have to be used for the maintenance and service of the different types of pipe lines, in years to come.

The Question of Valve Manholes.—Let me offer as an illustration, the question of whether or not to plan for the installation of valve manholes or to use the practice of simply installing a valve box. It seems obvious that it is much more economical in the end to use the manhole installation, even though the first cost is slightly more, for it is much cheaper to simply raise the manhole cover, than to have to remove and replace pavement, and completely uncover the valve every time it needs repairing. I have used the above illustration for the reason that it has been brought before me very forcibly in the last year, inasmuch as we have instituted a continuous system of valve inspection and maintenance and through that we found at least 50 per cent of our valves needed servicing of some kind. The maintenance was made doubly expensive by the fact that very few of the valves had been set in manholes during the original construction.

The Size of Mains.—The question of what size lines to lay in the different parts of the system plays an important part in the cost of water main construction. The thought runs in my mind that to date, we haven't lived long enough to know what to anticipate as the life of a cast iron water pipe under natural conditions. Cast iron water mains, of course, have failed from unnatural conditions such as electrolosis, acid action and other forms of oxidization due to certain local conditions, which in most cases can be remedied. With this fact before us it becomes apparent that we should plan the size of the installation to care for the demands that may be made on it at least 100 years hence. I ask permission to use another illustration. It was very surprising to me to find that in the City of Topeka, where the mains were first laid only 40 years back that one of the streets in the very heart of the business district was serviced with only a 4 in. line. I have reference to distribution lines and not to main feeder lines. From pumping stations; the size of which are automatically controlled either by the volume of water at your disposal at the pumping plant, or by the conditions existing with respect to the relative location of the pumping plant and the distribution system.

Two Main Systems.—To get back to the distribution system; several cities have already gone to the installation of what is known as the two main system, among which are Boston, Chicago, Detroit, New York, Cleveland, St. Louis and several others. This, as is inferred in the name, consists of laying a main on either side of the street behind the curb.

Hydrant Installations. — It would seem that the question of the number and type of hydrant installations should have a prominent place in the planning of distribution systems. I am of the opinion that hydrants should never be set on less than a 6-in. leg and that all the legs should be valved where they leave the main. Careful thought should also be given to the method of setting the hydrant so that adequate drainage will be provided and the drain also protected from the growth of roots, and other natural processes which tend to clog the drain and cause trouble in the operation of the hydrant.

Valves.—The matter of valves now presents itself. As mentioned before I am thoroughly convinced that all valves should be installed in manholes during the original construction. We should give careful consideration to the number and location of valves. It should not be necessary to valve off and kill the service in eight or ten blocks, to repair a broken main in one block, inasmuch as the main was originally laid for service to the consumer, and he has every right to expect an uninterrupted service, and we should prepare to deliver that service.

Establishment of Official Grade.—The planned design of all parts of a distribution, since the lines are generally laid ahead of all real estate development and the paving and sewer projects; must necessarily be dependent on the establishment of an official grade, by the city engineers office and made legal through ordinance by the city commission.

This idea has been in use in several of the larger cities for some time and has, in one way and another, saved them thousands of dollars for the simple reason that it is possible to plan all construction from a given point; and does not necessitate the changing of one plan to conform to another, either before or after the work has been completed. I mention this for the reason that in so many cases we plan and lay our lines then find that after the paving is completed we are without sufficient protection from frost, and thereby are forced to revamp, at a large expense, a part of our completed work.

The various thoughts mentioned in this paper are all vital parts of the cost of water main construction and unless we consider them, as such, we are merely fooling ourselves as to the real costs of our water mains.

Acknowledgment.—The foregoing is an abstract of a paper presented before the Kansas Water Works Association.

Decline in Death Rate at Boston, Mass.—In 1875 the city of Boston published a report of a special medical commission on The Sanitary Condition of Boston, which contains a wealth of suggestive information. At that time the death rate of Boston had varied from a maximum of 31.8 per 1,000 for the year 1872 to a minimum of 22.3 for the year 1867, but giving a mean annual death rate for a ten-year period of about 25 per 1,000. The death rate of Boston for the year 1927 will be about 14 per 1,000, or an annual saving of 11 per 1,000, equivalent, on the estimated population of Boston, to 11.102 deaths.

Earth Current Surveys for New Pipe Lines

Importance of Preliminary Survey of Electrical Conditions

By E. E. MINOR
Chief Engineer, New Haven Water Co., New Haven, Conn.

IN the selection of a route for a new feeder main, geographical and profile studies may not present all of the engineering aspects of the problem which need consideration. Stray currents, which are often overlooked in the location of a new pipe line, may be the governing factor in the eventual life of the pipe. Therefore, they are decidedly worth studying before the pipe line location is definitely decided upon. If hazardous conditions are found on one route, it may be possible to avoid them on another, or as often happens, the stray current hazards can be materially reduced or eliminated before the pipe is laid. An accurate knowledge of all phases of the stray current problem as it affects the new pipe line is also of vital importance in the design and construction of the lien, because mitigative measures can be applied much more easily and cheaply as the line is laid, than they can after the job is once completed.

In developing a water supply for New Haven we have planned a 48-in. pipe line coming into New Haven on the east. This roughly parallels an interurban electric railway for about 5 miles. The soil is for the most part sandy and of relatively high electrical resistivity. Approaching the city we pass under another electric interurban line with the soil changing to low salt water marshes of low resistance, through which our line would pass for about 2,000 ft. and then under a broad tidal estuary, 1,500 ft. in width, to a sandy high resistance soil in the city.

Earth current surveys were made by Albert F. Ganz, Inc., of New York City under the direction of its engineer, C. F. Meyerherm. The results were surprising and we have included the report in this paper, thinking it would be of interest, in a general way, to members of the Association. Here are soil resistances ranging from 420 to 126,000 ohm-centimeters; voltage gradients running from neglible values up to magnitudes of 282 volts per thousand feet. Needless to say, much improvement will be made in these conditions before our pipe is laid. We believe it shows, however, the value of investigating these conditions before installing thousands of dollars in pipe line which would be immediately subject to depreciation from causes which could be partly eliminated and partly guarded against. The report follows:

Report on Electrolysis Survey.—In accordance with our understanding with you we have made a series of electrolysis tests at characteristic points along the route of the proposed North Branford-New Haven water supply main and we give you herewith our report on the results.

The object of the present investigation was to determine: (a) existing stray current gradients in the earth in the territory through which the proposed pipe line will pass; (b) the electrical resistivity of the soil at characteristic points along the route; and (c) the most desirable locations for any electrically insulating joints which might have to be installed in this pipe line in order to minimize stray current electrolysis action on this pipe line.

We understand the proposed water main will be a 48-in. cast iron line laid along Foxon Road, and therefore approximately parallel to the New Haven and Shore Line Railway tracks from North Branford to the junction of Foxon Road and Essex Street, Fair Haven. At the latter point the pipe line will turn into Essex Street which it will follow to Quinnipiac Avenue. At Essex Street and Quinnipiac Avenue, the new line will reduce to 42-in. and then continue by private right of way through the salt meadows bordering the east bank of the Qunnipiac River, crossing the river to Peck Street, New Haven. Along Peck Street, the new North Branford supply line will continue west to Blatchley Avenue where it will connect to a new 24-in. cross main which will run from Grand Avenue through Blatchley Avenue and Willow Street to Whitney Avenue.

Measurements of soil resistivity and of voltage gradients existing in the earth both parallel and at right angles to the proposed pipe line were made at the following characteristic locations:

1. In the salt marsh just east of the New York, New Haven and Hartford R. R. embankment (Shore Line Division).
2. In the high ground just west of Quinnipiac Ave.
3. On Essex Street in the high ground just east of Quinnipiac Ave.
4. On Essex Street approximately 500 feet east of Quinnipiac Ave.
5. Near the junction of Essex Street and Foxon Road.
6. At Foxon near the L. H. Goodrich property.

Soil resistivity tests were made at all of the above locations with the earth-current meter and the regular four terminal earth-current meter electrode inserted in a 2½-inch hole drilled in the earth to approximate pipe depth. Gradient tests were made at four locations with a Rawson voltmeter and a minal earth-current meter electrode inserted in the earth at points 100 ft. apart except at location No. 6 where the spacing had to be reduced to 50 ft.

The results of the tests are given in Table I.

It will be noted that in the salt marsh just east of the New York, New Haven and Hartford Shore Line Division railroad embankment the soil resistivity is exceptionally low averaging only 420 ohm-centimeters. In the slightly higher ground near Quinnipiac Avenue, the soil resistivity was extremely high, averaging 122,400 ohm-centimeters,

Table 1.—Earth Gradient and Soil Resistivity Measurements Along Route of Proposed North Branford-New Haven Water Supply Main, June 20-21, 1928

Location and Character of Soil	Average Soil Resistivity, Ohm-Centimeters	Earth Gradient Volts per Thousand Feet Parallel to Pipe Maximum	Parallel to Pipe Average	Transverse Maximum	Transverse Average
300 ft. west of Quinnipiac Avenue at Essex Street:					
Black meadow mud	420				
Essex Street, just west of Quinnipiac Avenue:					
Red sand and loam	122,400			2.3S 0.4N	0.83S 0.06N
Red sand and loam (60 minutes test)		10.0E 32.0W	3.4E 1.1W		
Essex Street (north side) just east of Quinnipiac Avenue:					
Red sand and loam	126,300	1.2SW	0.83SW	2.4NW 10.0SE	0.77NW 0.98SE
Essex Street (north side) 500 ft. Northeast of Quinnipiac Avenue:					
Red sand and loam	7,520				
Foxon Road, opposite Capella's Gas Station south of Shore Line tracks:					
Red sand and loam	70,600	3.0SW 0.4NE	0.77SW 0.03NE	6.8SE	2.0SE
Foxon Road, 75ft. east of Shore Line Pole No. 176 (L. H. Goodrich property) north of tracks:					
Red clay and sand	58,800	1.0E	0.61E	1.0S 200N	0.05S 8.8N
Red clay and sand (265 minutes test)				62.0S 282N	Neg. 23.0N

west of Quinnipiac Avenue, and 126,300 ohm-centimeters on Essex Street just east of Quinnipiac Avenue. About 300 or 400 feet further east, Essex Street runs through salt marsh and in this locality the soil resistivity averaged 7,520 ohm-centimeters. At Foxon Road and Essex Street, where the new pipe will run parallel and close to the New Haven and Shore Line tracks the soil resistivity averaged 70,600 ohm-centimeters while in the town of Foxon it averaged 58,000 ohm-centimeters.

The tests of voltage gradient in earth showed that in the vicinity of Quinnipiac Avenue there is an extremely high voltage gradient in earth at right angles to the Qunnipiac Avenue trolley tracks of The Connecticut Company, and therefore practically in line with the proposed pipe line. The maximum gradient along the line noted at the locations either side of Quinnipiac Avenue ranged from 1.2 to 32 volts per 1,000 ft., while the maximum gradient at right angles to the line ranged from 0.4 to 10 volts per 1,000 ft.

At Foxon Road and Essex Street the gradients were not as high as they were near Quinnipiac Avenue, but yet the maximum values ranged from 30 volts per thousand feet parallel to the line to 6.8 volts at right angles. At Foxon the maximum gradient parallel to the line was 1.0 volt, while the maximum gradient at right angles to the line exceeded 200 volts per thousand feet in the field north of Foxon Road near the L. H. Goodrich property. This occurred with a New Haven and Shore Line car operating in the immediate vicinity. To determine the actual maximum value attained by this gradient, a six-hour test was made with a special high sensitivity recorder and non-polarized electrodes. At the same time an eighteen-hour record of the potential of the trolley rails referred to earth six feet away from the rail was obtained. This gradient record shows a maximum of 282 volts per thousand feet at this location and the potential test showed the rails reversing to earth at times, becoming as much as 70 volts positive in potential to adjacent earth.

It is evident that at practically all locations where tests were made in the Foxon Road territory the voltage gradients existing in the earth were far in excess of the limitation of one volt per thousand feet ordinarily set for reasonably safe electrolysis conditions. In fact the earth gradients along the route of the proposed North Branford water supply line are so high that it would be practically impossible effectively to protect the proposed pipe line against stray current action under existing railway conditions. It is true that generally speaking the soil resistivity is comparatively high and that as a result the existing stray current density in the earth is low. This, however, would merely accentuate trouble on a metallically continuous pipe line which would have to run through the low as well as through the high resistance soil. Stray current interchange between such a pipe line and earth would be extremely localized in the soil areas where the resistivity was very low or moderately low.

In addition, the proposed route involves a long exposure to stray currents and since the pipe will be large in size and low in electrical resistance comparatively large amounts of stray current could be picked up even in the high resistivity soil. For this reason any attempt to break up the electrical continuity of the proposed pipe line with isolated insulating joints would be certain to result in high differences in potential across such joints. Even if every pipe joint were made insulating, a gradient of 32 volts per thousand feet parallel to the pipe, such as exists near Quinnipiac Avenue would mean a potential difference of 0.4 volt across each bell joint. Such a potential would be far too high for safety, with any of the practically feasible non-metallic pipe jointing materials like Leadite or Hydro-Tite.

The high voltage gradients existing in the earth in the Foxon Road territory can only be due to an extremely defective track return circuit system on the railway line in this area, and the obvious remedy is the elimination of these defects. In the case of the Quinnipiac Avenue line, we know that the crossing with the New Haven and Shore Line Railway was in bad condition, because an indicating voltmeter test showed a potential as high as 18 volts across this cross-over both in a north to south as well as in an east to west direction. In the case of the New Haven and Shore Line Railway, visual inspection of short sections of track indicated a large number of bonds missing, and the additional possibility of existing bonds having a high electrical resistance because of their being of the pin terminal type whose electrical conductivity is not always perfect to begin with and apt to deteriorate with vibration and age. Another factor tending to radically increase stray currents from the Shore Line system was the comparatively long direct-current feed existing at the time of our tests, due to the Totoket Substation of this trolley being out of service. Apparently this substation was not being operated regularly, and this meant that the entire New Haven and Shore Line Railway was being supplied from the Grand Avenue station of The Connecticut Company in New Haven and a New Haven and Shore Line Substation in Guilford.

Conclusions.—The ultimate safety of the proposed North Branford-New Haven water supply main from stray current hazards demands that the present abnormally excessive track drops existing on the railways in this territory be materially reduced and maintained at a small fraction of their present magnitude. This will involve (a) test of all rail bonds and special work jumper cables, (b) immediate replacement of all missing or defective bonds or special work jumper cables, (c) operation of the Totoket Substation of the New Haven and Shore Line Railway system at least during periods when cars are operating between North Branford and New Haven, and (d) thorough and continuous maintenance of the general electrical conductivity of the track return systems.

Assuming adoption of such railway return circuit improvements as will reduce track drops and earth gradients to reasonable values, it would be well to break up the electrical continuity of the proposed pipe line at several points on both sides of the Quinnipiac River before the line enters the low wet ground bordering the river. From the data which we have obtained so far, the best locations for insulating joints on the east side of the river would be in the high-resistance soil (a) near Essex Street and Foxon Road; (b) just east of Quinnipiac Avenue; and (c) just west of Quinnipiac Avenue. On the west side of the Quinnipiac River, we understand the line will run in clean river sand along the greater part of Peck Street, and several insulating joints should be installed in this section at locations where the soil resistivity is high and where the joints will not be by-passed by connections to the general water distribution system.

Since the expense of installing insulating joints when a pipe is being laid is comparatively small, we would also suggest the installation of additional insulating joints in the proposed pipe line about 500 ft. either side of the crossing with the New Haven and Shore Line track on Foxon Road near Eastern Street, and in the Town of Foxon at 1,000-ft. intervals along the section where the pipe will closely parallel the trolley tracks.

The electrical effectiveness of all insulating joints should be determined by test both just before and after they are put into the line in order to safeguard against breakdowns resulting from handling. All of the insulating joints and the pipe for a few feet on either side could be covered with an insulating coating of tar or asphalt to increase the length of the earth path around these joints. After the line is complete, tests should be made to ascertain whether or not dangerous shunting action exists at any of the joints. To facilitate the latter tests it would be well to install permanent electrical test stations, as the pipe is laid, approximately midway between each pair of insulating joints. On the river section of the main, one such test station should be installed 200 or 300 ft. west of the easterly insulating joint and another, 200 or 300 ft. east of the westerly insulating joint.

Acknowledgment.—The foregoing is an abstract of a paper presented before the New York Section of the American Water Works Association.

Construction of a Small Reinforced-Concrete Bridge

Span of T-Beam Design Built at Laconia, N. H.

By CHARLES A. FRENCH
City Engineer and Superintendent of Public Works, Laconia, N. H.

IN December of last year the city of Laconia, N. H., completed the new reinforced-concrete Church St. bridge, spanning the Winnipesaukee River. This is one of the most important stream crossings in the city and carries the Daniel Webster Highway, the central trunk-line highway of New Hampshire, which is subjected to very heavy traffic.

Replaces Old Timber Trestle.—The river at this point has been spanned since 1840 by a timber bridge resting on mud sills on the river bottom, with split stone abutments at either end resting on logs embedded in the river bed. It had been found necessary to renew this structure at frequent intervals, and the resultant expense and annoyance to traffic were considerable. A movement toward replacement of the old structure was begun in 1908, when Sanford E. Thompson prepared plans and specifications for a two-span arch bridge having a total length of 135 ft. and an over-all width of 50 ft. Since the permissible street grade was but 9.8 ft. above the level of the water, it was necessary to design very flat arches. The problem was complicated by the absence of favorable foundation conditions at the ends of the proposed span.

The city council failed to provide appropriate funds to carry out this project and ordered the reconstruction of the timber bridge, which was maintained with great difficulty until 1928.

Reinforced-Concrete Bridge Chosen.—In 1928, because of the increased flow of traffic and heavier loading, it was decided to construct a reinforced-concrete bridge suited to modern traffic conditions. Public sentiment demanded a structure of pleasing appearance at this point, which requirement eliminated some types that might have been built more cheaply.

The department of public works had built previously two T-beam reinforced-concrete bridges at other locations with considerable success and, in view of the conditions existing at this site, it was decided to design a similar structure, to be built by the forces of the department. Because of the limited head room it was necessary to make the depths of the beams as small as possible. In order to satisfy the public demand for a structure of acceptable appearance, the exterior beams were made to resemble arches.

Borings at the abutments and at the pier locations indicated that a coarse gravel bottom existed at from 17 to 20 ft. below water level, overlaid by coarse sand, fine sand and silt, from 6 to 16 ft. in depth.

The river opening of 150 ft. was divided into three spans, each 46 ft. 11 in. in the clear. The bridge was designed for a 20-ton truck loading, with 30 per cent added for impact. The girders were designed as continuous beams, with an expansion joint provided at each abutment. No fill or special surface was provided for the roadway, but traffic was carried directly upon the slab. The concrete may be surfaced later if the wear seems to indicate that this is necessary.

The spans are carried on nine T-beams, 3 ft. 2½ in. in depth and 18 in. wide. The roadway slab is 7½ in. deep.

Church St. Bridge in Laconia, N. H., Carries the Daniel Webster Highway, an Important New England Trunk Line, Across the Winnipesaukee River

This Bridge Consists of T-Beam Spans, but the Exterior Beams Were Made to Resemble Arches in Compliance with the Public Demand for a Bridge of Pleasing Appearance

The slab is cantilevered for a distance of 3 ft. beyond the exterior beams to carry a portion of the sidewalk and the railing. Ornamental lamps are provided at the piers and abutments.

Construction.—It was necessary to close Church St. to all vehicular traffic during construction of the bridge. A foot bridge was built for the use of pedestrians. In general, limited space prevented the storage of much material at the site, and this hampered construction to a certain degree.

Considerable difficulty was afforded in the construction of the piers by a 12-in. sanitary sewer crossing the river through a cast-iron syphon, which conflicted with the location of the piers. Chiefly because of this sewer, it was decided to construct the piers and abutments in unwatered cofferdams. It was necessary to construct two cofferdams for each pier and abutment, as it was found that the material in the river bottom could not otherwise be held around the sewer when the cofferdams were dewatered.

An attempt was made to build timber cofferdams consisting of an inner and an outer shell with fill between, but it was found that the plank sheathing could not be driven deep enough to prevent the blowing up of the bottom of the excavation when pumped out. Lackawanna steel sheet piling was substituted for planking in the inside shells of the cofferdams, and this was successful in preventing blowouts. The cofferdams were excavated to suitable foundation material, which was found at an average depth of 15 ft. below water level.

The piers were built in two sections until the top of the sewer was reached, where the sections were joined into a continuous structure. Additional reinforcement was placed in the piers above the level of the sewer to tie the sections together securely and prevent any possible tendency to split above the sewer. There has been no indication of any settlement or movement of the piers or abutments since construction.

Local sand and crushed stone were used for concrete aggregate. The concrete was mixed in the approximate proportion of 1:2.5:3.5. About 6 gal. of water were used per bag of cement, and the proportions of aggregates were varied to secure a workable mixture for the various portions of the structure.

All forms, including forms for the balustrades, were fabricated on the job. The balustrades were poured in place. All exposed surfaces were rubbed with carborundum brick to remove form marks and secure a pleasing finish.

Work was commenced on April 20, 1928, and was finished Dec. 3. Traffic was allowed over the structure Oct. 17. The construction of the cofferdams for the piers was necessarily slow and accounted for a large part of the time consumed. Some delay was caused by cold weather in the latter part of November, which retarded the removal of the balustrade forms and the finishing.

Cost.—The total cost of the project was $43,932.60, divided as follows:

Demolition of old bridge; construction and removal of foot bridge	$ 664.75
Excavation and cofferdams	17,178.48
Concrete, forms, reinforcing, finishing	21,132.50
Engineering, overhead, insurance, miscellaneous	4,956.87
Total cost	$43,932.60

Personnel.—The bridge was designed by the writer, assisted by Miles N. Clair of the Boston firm of Thompson & Lichtner. Construction was under the supervision of the writer, with Hartley E. Hamm as construction foreman.

Modern Motor Fire Engines

Modern fire-apparatus units have many features in common with conventional motor vehicle practice but perform functions in no wise parallel to those of the ordinary motor vehicle, said Charles Fox, of the Ahrens-Fox Fire Engine Co., at a recent meeting of the Dayton Section of the Society of Automotive Engineers.

Motorization of fire departments began in a rather desultory way about 1910, and in time gasoline-powered fire engines "made good," considerably before the fact was conceded by the fire commissioners and chiefs. The way for complete motorization of the fire departments was paved by motor ladder-trucks, hose wagons, chemical engines and the like.

Three distinctly different types of pumps are now in general use on motor fire engines, according to Mr. Fox. These are the piston, the rotary, and the centrifugal types. The effect upon the powerplant incidental to the varying relation between volume and pressure is comparable, he said, with the varying load on the engine of an automobile when traveling on the road. When the pumps go into action, the volume of water discharged represents a moving weight, and the pressure at which the water leaves the pumps is the equivalent of a definite vertical height through which the weight is transported. Thus the volume and pressure constitute the load of the pump.

Zoned Municipalities in the United States

The Latest Government Report on Zoning Progress

MORE than 37,000,000 people, residing in 754 cities, towns and villages, comprising three-fifths of the urban population of the United States, now have the protection afforded by zoning regulations, according to a survey just completed by the Division of Building and Housing of the Department of Commerce. The zoned municipalities mentioned above include cities, towns and villages of various sizes and types located in all parts of the country. The results of the survey have been made public in the form of a bulletin compiled by Norman L. Knauss, and issued on April 1 by the Division of Building and Housing, of which James S. Taylor is acting chief. The notes following are taken from the bulletin.

Zoning Progress to 1928.—Viewing the progress of zoning in the United States from the standpoint of ordinances adopted, the eight zoned cities by the end of 1916 were augmented to 38 in 1920. The number of zoned municipalities was doubled in 1921, the total being 76. In 1922 New Jersey, New York, Illinois and Massachusetts showed considerable activity, the additions amounting to 101, which increased the total number of zoned municipalities to 177. During 1923, cities in California and Illinois were more active than in the preceding year, while cities in New York, New Jersey and Massachusetts were less active—but with other states zoning, many for the first time, the year netted 106 zoning ordinances and brought the total to 283. In 1924 76 municipalities adopted zoning ordinances; in 1925 there was increased activity in zoning legislation in the states of Connecticut, Indiana, Iowa and Pennsylvania, and zoning ordinances were adopted by 109 municipalities. Ninety-six municipalities zoned in 1926; 107 zoned in 1927; and 87 municipalities were reported having zoned in 1928; bringing the total number of zoned municipalities to 754.

Zoning During 1928.—Eighty-seven cities, towns and villages were reported to the Division of Building and Housing as having zoned during 1928; while 101 other municipalities were reported as having either adopted more comprehensive zoning ordinances or amended existing ordinance thereby making their zoning more effective.

An analysis of the 87 zoning ordinances reveals that 44 were comprehensive, regulating the use, height, and area of buildings; 27 merely controlled the use of buildings; seven regulated the use and area of buildings; and two were interim ordinances, adopted pending the more careful preparation of zoning ordinance looking to the future.

As a result of either the amendments or the revision of their zoning ordinances, 77 of the 101 zoned municipalities, that originally zoned prior to 1928, now have comprehensive zoning ordinances in effect.

Reports received from all parts of the country indicate a continuing zoning activity in all states. New York state not only leads with a total of 131 zoned municipalities, but also excelled all of the states in the number of municipalities zoned during 1928, with 23 zoned cities, towns and villages. Ohio and Pennsylvania were tied for second place, with six each.

Youngstown, O., Waterbury, Conn., and Altoona, Pa., were three of the largest cities which enacted zoning legislation. Cleveland, O., passed a comprehensive zoning ordinance on Oct. 1, 1928, but the ordinance was made inoperative on Nov. 26 upon the filing of a referendum petition thereon. A new ordinance, almost identical with the one repealed, was introduced on Nov. 16, but had not been adopted by the end of the year.

South Dakota and Idaho were added to the states having zoned municipalities when four cities in the former and three cities of the latter adopted zoning ordinances during the year.

Maryland and Georgia showed progress in county zoning. Prince Georges and Montgomery counties, Maryland, put comprehensive zoning ordinances into effect in areas adjacent to the city of Washington, D. C., and Glynn county, Georgia, adopted such an ordinance applying to its entire area. Township zoning in Pennsylvania has shown progress, with a comprehensive zoning ordinance for Radnor Township added in 1928.

Zoned Municipalities Grouped According to Population.—In grouping the zoned municipalities according to population it was found that 56 of the 68 largest cities having over 100,000 population (1920 Census) were zoned. The zoned municipalities in the population groups total as follows:

- 56 cities having over 100,000 population;
- 79 cities having less than 100,000, but more than 40,000 population;
- 86 cities and towns, having less than 40,000, but more than 20,000 population;
- 96 municipalities having less than 20,000, but more than 10,000 population;
- 132 municipalities having less than 10,000, but more than 5,000 population;
- 89 municipalities having less than 5,000, but more than 3,000 population;
- 119 municipalities having less than 3,000, but more than 1,000 population; and
- 97 municipalities having less than 1,000 population.

New York State Leads.—New York state still leads in the number of zoned municipalities. Massachusetts, New Jersey, Pennsylvania, Ohio, Illinois, Kansas, Wisconsin and California also rank high.

Most Active States Since 1916.—Ordinances regulating the height, and also the use of buildings were adopted prior to the enactment of the first comprehensive zoning ordinance enacted by New York City. Since then, the states showing the greatest zoning activity have been as follows:

- 1917—California, 4 zoned municipalities;
- 1919—California and Wisconsin, 2 each;
- 1920—New Jersey, 4; and California and New York, 3 each;
- 1921—New Jersey, 19; New York, 7;
- 1922—New Jersey, 30; New York, 22; Illinois, 10; Massachusetts, 8; and Ohio, 6;
- 1923—New Jersey, 19; Illinois and New York, 16 each; and California, 15;
- 1924—Illinois and New York, 13 each; Massachusetts, 10; California, 7; and Iowa and Pennsylvania, 5 each;
- 1925—Pennsylvania, 17; Massachusetts, 16; New York, 13; and California and Massachusetts, 8 each;
- 1926—Illinois and New York, 16 each; and Kansas, Massachusetts and Pennsylvania, 6 each;
- 1927—New York, 16; California, 12; Massachusetts, 10; Kansas, 9; and Pennsylvania, 8; and
- 1928—New York, 23; and Indiana, Ohio and Pennsylvania, 6 each.

States Having Most Zoned Municipalities.—When the states are listed according to the number of zoned municipalities, New York leads by a substantial margin, having a total of 131 zoned municipalities. New Jersey is second with 84 places; California, third with 73; Illinois, fourth with 71; Massachusetts, fifth with 62; Pennsylvania, sixth with 43; Ohio, seventh with 41; Michigan, eighth with 31; Wisconsin, ninth with 30; and Kansas, tenth with 23. Then follow Connecticut and Indiana, 17 each; Iowa, 14; Florida, 12; Rhode Island, 9; Missouri and Virginia,

8 each; Nebraska and Oklahoma, 7 each; North Carolina, 6; Colorado, 5; Alabama, North Dakota, South Dakota, and Tennessee, 4 each; Georgia, Idaho, Maryland, Minnesota, New Hampshire, Oregon, Utah and Washington, 3 each; Arizona, Arkansas, Kentucky and Maine, 2 each; and Delaware, District of Columbia, Louisiana, Mississippi, Nevada, South Carolina and Texas, 1 each.

Majority of Zoning Ordinances are Comprehensive.—An examination of the zoning ordinances of the 754 municipalities noted in the survey disclosed that 475 were comprehensive in scope, regulating the use, height and area of buildings. Of the 279 other zoning ordinances, most controlled the use to which buildings and premises could be put, although 45 of the number also controlled the area of buildings; and 10 others controlled the use and height of buildings.

Few Changes Made in Zoning Ordinances.—Questionnaires were sent to all municipalities throughout the United States having authority to zone under state zoning enabling acts. Most of the municipalities that had enacted zoning ordinances prior to 1928 reported that the early zoning ordinances were still in effect. A few cities stated that minor changes had been made in their zoning ordinances, as, for instance, the extending of the boundaries of the various districts, principally in regard to the use districts, wherein the use of buildings and grounds were controlled. A few others reported having revised their zoning ordinances as, for example, enacting a comprehensive zoning ordinance regulating the use, height and area of buildings, taking the place of an ordinance previously adopted which only controlled the use to which buildings could be put.

Considerable zoning activity was indicated by the returns from municipalities not yet zoned, and in returning the questionnaires, many of the city officials asked for information on the subject.

Court Decision on Permits for Garbage Transportation

An interesting court decision on the issuance of permits to remove and transport garbage in a city, is cited in the March 29 Public Health News. The decision was handed down Aug. 3, 1928, by the Ohio Court of Appeals in the case of the City of Cincinnati et al. v. State ex rel. Moock, 164 N. E. 771.

A section of the municipal ordinances of the city of Cincinnati provided as follows:

> That no person shall remove or carry in or through any of the streets * * * of the city * * * any house dirt or house offal, animal or vegetable, or any refuse substance, from any of the dwelling houses or other places of the city, or carcass of any dead animal, unless the owner of the same shall have procured a permit so to do from the director of public service * * * Provided, however, the provisions hereof shall not apply to any contractor with the city in relation to garbage * * *.
>
> It is hereby made the duty of the contractor with the city * * * to collect and remove * * * all garbage and refuse, animal, fish, or vegetable matter found within the city limits; and also all dead animals which are not removed or disposed of by the owner * * *. Except as herein provided as to dead animals, no other person or party than the city contractor or its agents shall carry, convey, or transport through the streets * * * such materials; and it shall be unlawful for any person to interfere in any manner with the collection and disposal of such materials by the city contractor.

The appellee brought a mandamus action to compel the city manager of Cincinnati to issue to him a permit to remove and transport through the city garbage and refuse. It appeared that the appellee had entered into an arrangement with certain hotels in the city to remove their garbage, for which he paid a small sum, and that he desired to convey the same through the city for feeding to his swine outside of the city. The city had an exclusive contract with a company for the disposal of all the garbage of the city.

The decision of the Court of Appeals sustained the refusal of the permit, such decision being summed up in the concluding paragraph of the opinion as follows:

> Our conclusion is that it is within the police power of the city to control the disposal of the garbage of the city in the way that it does; that the city manager did not abuse his discretion in refusing the permit and granting the exclusive collection to an individual corporation, and that there is no violation of any constitutional rights of the realtor.

To Reduce City Traffic Congestion

Discussing the questions of store-door delivery and reduction of city-street congestion, in the April issue of the S. A. E. Journal, George W. Daniels, of the U. S. Trucking Corp., states that the big manufacturing centers in New York City, such as the garment center, are innumerable congested points. Buildings in these districts house from 10 to 20 tenants each. Some receive one case at a time and others ten, and probably every tenant uses a different truckman. Often the goods are brought from mills having a truckman in the city who delivers for them. That adds other truckmen. Trucks are now loaded at night for the uptown section, and the man who gets to the door first is lucky. If he has to make two deliveries in one building, he can make one promptly, but while the receipt is being signed another truckman beats him out on the second delivery, so he loses from one-half hour to one and one-half hours to make the second delivery.

In any new building of more than one tenant the ground floor should be devoted, says Mr. Daniels, entirely to the receipt and shipment of merchandise, the raw material going into and finished products coming out of that building. There should be one truckman for each building. This man would bring all goods to that one building and he would use only one, two or three trucks where ten create congestion at present.

Ohio Sewage Conference

The third annual Ohio Conference on Sewage Treatment will be held in Canton, O. This decison was reached at a recent meeting of the Conference Executive Committee. Determination of the date was deferred, although two tentative suggestions were made—the week of Oct. 8 and the week of Oct. 22. The meeting will be held in the same week as the Ohio Conference on Water Purification, and dates mutually satisfactory will be selected soon, so timed that those who wish can attend both conferences. The water purification conference will be held in Columbus.

An ever-increasing interest on the part of municipal officials in sewage treatment and plant operation should assure a large attendance.

It is planned to expand the meeting into a two-day session and to include opportunity to inspect the Canton sewage treatment plant and the new Salem plant. The former, under supervision of Charles C. Hommon, formerly with the State Department of Health, comprises Imhoff tanks and trickling filters, and has been in operation about three years. The Salem plant embodies the most modern practice in the activated sludge process and is a new plant—the first of its kind in Ohio.

Collection of Garbage by City Held to Be Governmental Function

The Supreme Court of Oklahoma on April 3, 1928, handed down a decision of considerable interest to municipal officials. The decision was rendered in the case of Oklahoma City vs. Baldwin (273 P. 453) and is cited as follows in Feb. 1, Public Health Reports:

An action to recover was brought against the city of Oklahoma City, it being alleged that property damage and personal injury had been sustained by reason of one of the garbage trucks of the city health department having negligently hit the car of the plaintiff. A recovery was had in the trial court, and the city appealed. There was thus presented to the supreme court for decision the question as to whether or not a city, in collecting its garbage, was acting in a governmental or corporate capacity. The court decided that the city, when collecting garbage, was discharging a governmental function, in the performance of which the city was not liable for the negligent acts of its agents.

The contention was made that, because the city charged a fee for the removal of garbage, it was acting in its corporate capacity, but the court stated that it did not think the fact that there was a charge necessarily made the removal a non-governmental function so as to render the city liable.

Improving the Operation of Water-Treatment Plants in Maryland

State Department of Health Suggests Methods, Checks Results

CLOSE cooperation of the Maryland State Department of Health with the water-supply treatment plants of municipalities throughout the state has resulted in a definite improvement of the operation of these plants, with a consequent reduction in diseases traceable to a lack of adequate sanitary facilities. Periodical inspection of water supplies, education of plant operators, recommendations of routine tests to be made at the plants and the collection of detailed data concerning equipment and operation are the most important steps in the control of treatment plants in Maryland, as outlined by Abel Wolman, Chief Engineer of the department.

Public Supplies Inspected Monthly.—The state is divided into three districts, to each of which a resident engineer is assigned. In addition to his other duties he makes at least monthly inspections of the public water supplies in his district. Now and then a plant will require his attention at more frequent intervals and in some instances for several days at a time. On these visits samples are collected for analyses in the laboratories of the department.

Determinations Recommended to Operators.—The determinations recommended to be made by the plant operators depend upon the qualifications of the individual operator and the nature of the treatment the supply is receiving. When chlorination is required, the dosage is regulated by residual chlorine tests, the aim being to maintain a 0.20-part-per-million residual chlorine at an absorption period of approximately 5 minutes. Where, in addition to chlorination, sedimentation and filtration and possibly softening or acidity control are required, the application of the chemicals is regulated by the well-known jar test.

In recommending outfits for this work to a town, the materials required are listed, and the plant authorities are given the names and addresses of several concerns, when possible, from which they can be purchased.

For determining residual chlorine, the La Motte-Enslow comparator is generaly used. The set consists of six chlorine color-standards with values of 0.1, 0.2, 0.4, 0.6, 0.8 and 1.0 part of chlorine per million, made up in sealed ampoules; three 15-cc. test-tubes; an ampoule of distilled water; a 50-cc. bottle of ortho-tolidine reagent and a calibrated pipette for measuring the reagent. The equipment is contained in a wooden case approximately 8 in. long, 2½ in. wide and 5½ in. high. The top of the block contains three slots, backed by etched glass, for convenience and accuracy in making the test comparisons.

STATE OF MARYLAND
FILTRATION PLANT CENSUS

NAME OF PLANT _____ Date _____

Source of Supply _____

Plant: Type; Designed Capacity - M G D; Average Daily Delivery - M G; Date Installed; Number

Mixing Basin: Arrangement of Baffles; Capacity - Gallons; Velocity - Ft per Sec; Efficiency

Settling Basin: Number; Type; Capacity - Gallons; Displacement Time - Hours; Efficiency

Filters: Number; Size; Capacity - M G D; Rate Controllers (Type, Condition, Efficiency); Wash Water Troughs (Non Dist between Troughs - Feet, Height of Troughs above Sand - Inches); Wash Water (Rate - Inches rise per Minute, Rate Gal per Sq Ft per Minute, Source, Pressure - Lb per Sq In, Modules used, Frequency); Sand (Depth - Inches, Effective Size, Uniformity Coefficient, Surface Condition, Mud Balls, Air Binding - in Winter, Air Binding - in Summer); Gravel (Depth - Inches - Total, Size - Each Layer, Depth of Each Layer, Evenness); Strainer System (Type, Condition during Wash (Even, Spouting, etc.), Troubles)

Valves

Condition of Appurtenances & Structures: Gauges (Rate Controllers, Loss of Head); Piping; Concrete

Chemical Feeding Machine

Chemical Equipment: Chlorinator (Type, Condition, Amount used, Residual Chlorine (5 Min. Orthotolidine)); Alum - Gr per Gal; Iron - Gr per Gal; Lime - Gr per Gal; Soda Ash - Gr per Gal; Sodium Aluminate - Gr per Gal

Supervision: Manpower; Sampling; General Conditions in Plant

Operator _____ Designer _____

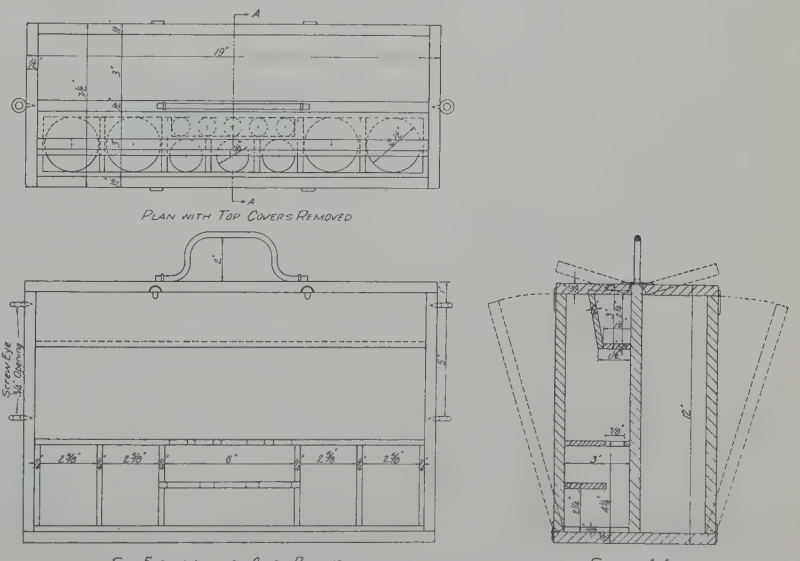
Remarks _____ Investigator _____

Form Used by the Maryland State Department of Health for Collecting Data on Filtration Plants

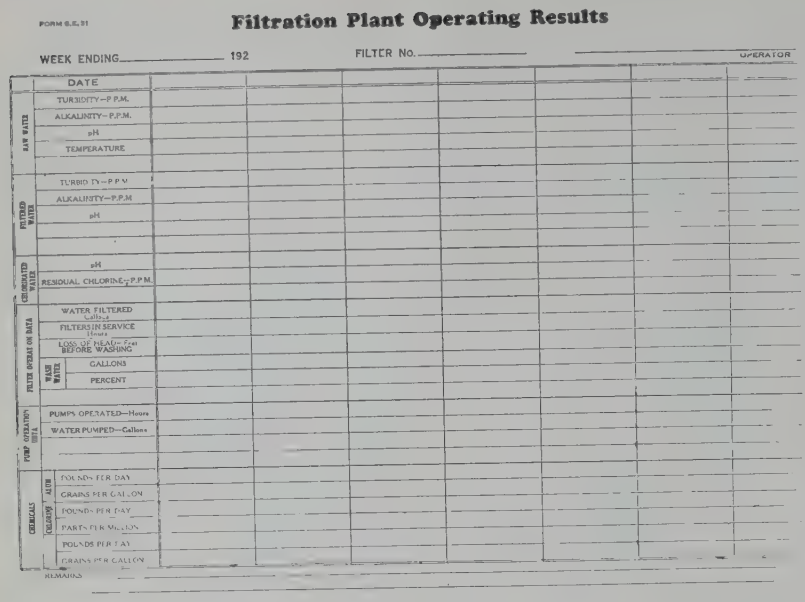
For hydrogen-ion concentration determinations, the La Motte block comparator, employing a colorimetric method, is most frequently purchased. The outfit is similar in design and size to the chlorine comparator described above. A knowledge of the general nature of the water acts as a guide in determining the pH range of color-standards applicable to a particular supply.

Field Laboratory Kit.—For the use of the department inspectors, there was recently devised a particularly satisfactory case for carrying the equipment necessary for field determinations of alkalinity, chlorides, CO_2, etc. The case, which is shown in an accompanying illustration, is 19 in. long, 7½ in. wide and 12 in. high. Although it was designed primarily for use in investigative work, it has been found convenient for demonstrations in instructing small plant operators and in enlisting the cooperation of town authorities.

Reports of Operators.—Accompanying are illustrations of an information sheet filled out by filter plant operators and a weekly report form submitted to the offices of the department. The purpose of the information sheet is to have on file, in convenient form, detailed data concerning each plant. These data are checked annually, although important changes that may occur at a plant are recorded at the time they are made. The data contained in the operators' weekly reports, as already suggested, vary in accordance with the nature of the treatment employed and the proficiency of the operator. Operators' re-



Field Laboratory Kit Designed for Maryland State Department of Health



Filtration Plant Operating Results

FORM S.E. 21

WEEK ENDING _____ 192 FILTER NO. _____ OPERATOR _____

	DATE	
RAW WATER	TURBIDITY—P.P.M.	
	ALKALINITY—P.P.M.	
	pH	
	TEMPERATURE	
FILTERED WATER	TURBIDITY—P.P.M.	
	ALKALINITY—P.P.M.	
	pH	
CHLORINATED WATER	pH	
	RESIDUAL CHLORINE—P.P.M.	
FILTER OPERATION DATA	WATER FILTERED Gallons	
	FILTERS IN SERVICE Hours	
	LOSS OF HEAD—Feet BEFORE WASHING	
	WASH WATER GALLONS	
	WASH WATER PERCENT	
PUMP OPERATING DATA	PUMPS OPERATED—Hours	
	WATER PUMPED—Gallons	
CHEMICALS	ALUM POUNDS PER DAY	
	ALUM GRAINS PER GALLON	
	CHLORINE POUNDS PER DAY	
	CHLORINE PARTS PER MILLION	
	LIME POUNDS PER DAY	
	LIME GRAINS PER GALLON	

REMARKS _____

Form of Weekly Report Submitted by Filter Plant Operators in Maryland Municipalities to the State Department of Health

ports are acknowledged with such comments as may appear desirable.

Large water treatment and sewage disposal plants are in charge of highly-trained operators who furnish monthly instead of weekly reports. These reports are, of course, in much greater detail than can be expected from the small-plant operators.

Department's Measures Successful.— A review of the typhoid fever record of Maryland seems to indicate that the efforts of the department of health in general are gradually being rewarded. The year 1928 showed by far the lowest typhoid fever incidence in the history of the state. The typhoid and para-typhoid fever mortality for the past year was 5.2 per 100,000 for the state at large, 4.2 for the city of Baltimore and 6.5 for the counties of Maryland. Ten years ago the rate for Maryland was 16.9 per 100,000. Systematic control over the public water supplies of the towns throughout the state may be held accountable for a good share of the decrease.

Political Interests Interfere. — In reckoning the amount of credit attributable to the measures of the State Department of Health here described, Mr. Wolman invites the attention of the observer to the not inconsiderable store of patience that must be brought to the business. Political and factional interests so frequently prove the controlling interests of a community that plant operators who have been fairly well trained have often failed in the past to live through municipal administrative changes. As a result, a good portion of the work of the department dealing with the education of operators and administrators must be repeated. However, those who have watched the progress of the campaign which is gradually spreading health information everywhere are confident that this adverse condition is being eliminated.

Research Work of Engineering Foundation

A science of humanics should be built up by research, it is declared in the annual report of the Engineering Foundation, made public by Director Alfred D. Flinn at 29 West 39th St., New York City.

"Experience," says the report, "is showing year after year the actual usefulness and the much greater possibilities of this joint research organization of our four senior national engineering societies with their 60,000 members.

"Even with small and uncertain resources, many members of these societies on special research committees are making valuable contributions of knowledge for the betterment of engineering and industrial practices. The public benefits, generally unaware.

"Research interests of engineers are not restricted to so-called material things. Improvement of the facilities for living and communicating lifts life steadily to higher intellectual, moral and spiritual levels, and promotes health, happiness and brotherliness. The engineer's studies must include the effects of his technical activities upon his fellow humans and their social organization."

During the year, according to the report, the Foundation continued its aid to researches concerned with arch dams, concrete arches, steel columns for bridges and buildings, blast furnace slags, electrical insulation, lubrication, engineering education, and painting of wood.

It also aided studies of fluid flow, cutting fluids used in cutting metals, engineering vocational selection, and other structural problems. Two new research projects are now under way. One relates to alloys of iron, and will embrace all forms of irons and steels. The other involves the materials, manufacture, and use of wire ropes.

The report tells of the Foundation's increased resources, and of its plans to raise further endowment, saying:

"Since 1915, the Engineering Foundation's capital funds have grown from $200,000 to $620,000 and its income from less than $10,000 a year to more than $30,000. This small income has been supplemented by cash, services, materials, and facilities, worth in the aggregate several times as much, contributed to projects which the Foundation has aided.

"These statements, however, are not the whole story. A number of engineers and other friends have let it be known that their wills contain direct or conditional bequests, and the number is increasing. These prospects for the future are encouraging.

"An Endowment Committee, appointed by the United Engineering Society for the Founder Societies has for members sixteen prominent engineers with Colonel E. A. Simmons, member of the American Society of Civil Engineers and the American Society of Mechanical Engineers, as chairman.

"This Committee is seeking $5,000,000 for the Engineering Foundation, and $2,000,000 for the Engineering Societies Library by direct gifts of cash or securities, bequests, life insurance, annuities, living trusts, or installment contributions.

"Projects in hand or waiting need substantial funds now; therefore, the Foundation especially invites the attention also of persons preferring donations for expenditure within a stipulated period, believing that the future will be at least as able as the present to provide for its own needs."

Testing Small Water Supplies in Rural Districts

The engineering Division and Division of Laboratories of the Ohio State Department of Health, cooperating with the district health commissioners, are endeavoring to inspect, analyze and report on the condition and safety of the public and semi-public small water supplies found in the rural districts and to mark with the Seal of Safety those found satisfactory. The form of the marker now used to identify safe supplies is a decalcomania of the State of Ohio outlined in yellow. In the center of the design is a yellow disc bearing the words "State of Ohio, Department of Health," near its outer edge, and "Seal of Safety" across the center. Above the yellow disc are the words "Safe Water." The field of the design is printed in gold.

Old Brick Pavements Relaid in Jacksonville

Methods and Costs in Florida City

By W. E. SHEDDAN
City Engineer, Jacksonville, Fla.

THE practice of laying vitrified brick pavements on natural subgrade with sand filler and without special foundation was followed quite generally in Jacksonville. Most of these pavements were constructed from 15 to 30 years ago and have served to carry traffic far in excess of that for which they were designed. With modern traffic and the motoring public demanding smooth riding pavements, city officials are faced with the need for rebuilding these streets and thoroughfares. Our study of this problem in Jacksonville led us to two definite conclusions:

1. Most of these pavements were not of sufficient width to meet modern traffic requirements.
2. The old brick had a definite salvage value and our examination of them indicated to us that from 60 per cent to 85 per cent were usable.

Salvage Quantities High.—The city of Jacksonville had some 50 or more miles of these pavements. It was recommended that certain streets be rebuilt with wider roadways. Forty, fifty and sixty-foot widths were selected, which conform to more or less standard widths used in this city. We are now completing this program and find that we somewhat underestimated the salvage quantities on all streets.

It was found that certain limited areas, constructed 30 or more years ago of small-size brick which were not figured of value in our relay program, actually produced more than 50 per cent reasonably good brick. These brick are usable for repair purposes and could be relaid on suitable foundations for light-traffic streets.

Other streets that have had from 18 to 25 years' service produced salvage quantities of usable brick averaging 75 per cent, and on some streets the salvage quantities exceeded 85 per cent. All these were "repress" brick approximately 3 in. x 4 in. x 8 in. in size which were originally laid on edge but in the relay program were laid flat. They cost when purchased from $21 to $25 per thousand, delivered in Jacksonville and the cost in place was from $1.25 to $1.60 per sq. yd., which is approximately 60 per cent of the present prevailing price.

Relay Bids Close and Low.—The relay program comprises approximately 55,000 sq. yd. or about 2½ miles of 40-ft. roadway. All pavements were relaid on 8-in. compacted Florida limerock base with sand cushion and standard bituminous filler. The old granite curbs were reset, new 20-ft. radii being used.

When this work was advertised the city was fortunate in getting a large list of responsible contractors to bid. The bids were close and low. The prices bid by the three lowest bidders for relaying with standard brick filler on limerock base ranged from 30 ct. to 45 ct. per sq. yd. The prices bid for base, which includes grading and adjustments, were from $1.06 to $1.29, and resetting of old granite curb ran from 11 ct. to 13 ct. The prices bid for new brick, 3-in. vertical fibre with bituminous filler, were from $1.62 to $1.93 with about the same range for base and curb.

The relay projects have more than fulfilled our expectations as to smoothness and general appearance.

Relaying Methods.—The bituminous filler was applied in the ordinary way. One contractor used pouring cans, heating his bitumen in ordinary 500-gallon kettles; another used the ordinary 500-gal. kettles for heating, the bitumen being distributed direct from the kettles by attaching a hose and letting it drag on the brick and spill out. The kettles were pulled with a roller. Both contractors used hot metal squeegees for spreading and cutting the bitumen on the brick surface.

The relay brick required an average of 13½ lb. of bitumen per sq. yd. and the new brick an average of 11½ lb. per sq. yd.

An Old Brick Pavement in Jacksonville Before Relaying. This Shows Duval St., Looking East from Georgia St.

Economy of Relay Program.—We figure that the over-all average cost per square yard for completed pavements on the seven relay projects was $2.44 and the over-all average cost per square yard for completed pavements on the new brick projects was $3.05, showing a difference of 61 ct. per sq. yd. This amounts to a saving to property owners and the city of $33,550 on the seven projects.

The cost shown for new brick is the cost after the salvage value of the old brick taken from these streets has been deducted. This salvage actually amounts to an average of 33 ct. per square yard, which would make the cost of new brick based on these bids $3.38 per square yard, showing that the savings are about equally divided between the streets from which the brick were taken and the streets on which they were used.

In figuring the cost of the relay

Old Brick Relaid on Market St., Jacksonville. This Pavement Was Relaid on an 8-In. Compacted Limerock Base with a 1-In. Sand Cushion and Bituminous Filler

brick, the value of the brick already on these streets and used in the relay was not shown; only the brick added to fill out added width were charged.

Saving was not only effected on the relay streets but also on the streets from which the brick were taken up and replaced with new materials. We credited to the streets from which they were moved, all usable brick at $20 per thousand; this effected from 85 ct. to $1 per front foot saving on these streets. The work was all done on a one-third—two-thirds plan, the city paying one-third of the total cost from bond issue funds and assessing two-thirds of the total cost to abutting property on a per-front-foot basis.

Duval County has utilized this plan in rebuilding county highways, having relaid approximately 30 miles of 16-ft. road on a somewhat similar specification, with about the same results.

Meeting of New York Section Am. W. W. Assoc.—The next meeting of the New York Section of the American Water Works Association is to be held May 2nd and 3rd, 1929, at the Mark Twain Hotel, Elmira, N. Y. Secretary, E. D. Case, The Pitometer Co., 50 Church St., New York, N. Y.

Pacific Northwest Water Works Men to Meet.—The next meeting of the Pacific Northwest Section of the American Water Works Association will be held May 15th and 16th, 1929, at Spokane, Wash. Secretary, Kenneth Shibley, 1005 Securities Building, Seattle, Wash.

Regulations Governing Missouri Public Water Supplies Revised

The regulations of the State Board of Health of Missouri governing public water supplies have been revised recently. The most radical change relates to the bacteriological analysis of public water supplies. As authorized at the present time this applies only to those public water supplies which do not have adequate laboratory facilities.

The present policy of the State Board of Health recognizes that the most satisfactory plan includes a bacteriological water laboratory in conjunction with all surface water purification plants. Until such a condition exists, the new regulations provide for weekly analyses of all public water supplies which require purification and have an adequate laboratory control. Also, regular bacteriological and chemical analyses by the State Board of Health are required for all ground water supplies.

Section 10, Part VI, of the Sanitary Code, governing the analysis required of public water supplies is quoted herewith from March Missouri Public Health News, the official publication of the State Board of Health.

Analysis of Water Required.—Samples of water from public water supplies shall be collected as authorized by the state board of health and examined bacteriologically and chemically at the laboratories of the state board of health. Not less than two samples of water for bacteriological examination and one sample of water for sanitary chemical analysis shall be collected each year from the ground water supplies which do not require purification. Not less than one sample of water each week for bacteriological examination and one sample of water each year for sanitary chemical analysis shall be collected from surface water supplies and ground water supplies that require purification.

The following rules shall govern the analyses of water samples required by this regulation:

(a) Submission of Water Samples. Water specimens for sanitary analysis shall be submitted in containers, furnished by the State Board of Health. Specimens shall be collected and packed in accordance with instructions enclosed in the container. Specimens which are not collected and packed as specified shall be discarded.

(b) Transportation Charges on Specimens. The owner submitting specimens to the State Board of Health Laboratories for analysis shall pay all transportation charges on said specimens. When specimens are submitted in containers which must be shipped by express, the owner submitting the specimens shall pay the transportation charges both from and to the State Board of Health Laboratories.

(c) Fees—Authority For. By virtue of the authority conferred upon the State Board of Health by Section 5778, Revised Statutes of Missouri, 1919, the following fees are established for the sanitary analysis of water specimens as required by this regulation.

(d) Fees—Public Water Supplies. Basis of Charges. 1. The annual fee for the required sanitary analysis of public water supplies, shall be based upon the last estimate of population made by the United States Census Bureau.

2. When the regular sanitary analysis of a public water supply is instituted later in the year than the month of January, the fee for the remainder of the year shall be prorated by months on the basis of the annual charge. The fees for sanitary analyses of water shall be paid in advance.

3. Ground Water Supplies. The fee for the required sanitary analyses of public water supplies of ground origin which do not require purification shall be as follows:

Population of Cities	Per Year
Under 500	$12
500 to 1,000	13
1,000 to 2,000	14
2,000 to 3,000	15
3,000 to 5,000	16
5,000 to 15,000	17
15,000 and above	18

4. Surface Water Supplies. The fee for the required sanitary analyses of public water supplies of surface origin and ground water supplies which require purification shall be as follows:

Population of Cities	Per Year
Under 1,500	$ 40
1,500 to 3,000	60
3,000 to 6,000	80
6,000 to 10,000	90
100,000 and above	100

Elevated Storage for Municipal Water Supply

Considerations in Selection of Elevated Storage Capacity

By DONALD H. MAXWELL
Principal Assistant Engineer, Alvord, Burdick & Howson, Consulting Engineers, Chicago, Ill.

MANY water works plants are undoubtedly under-developed in provision for elevated storage, while a few have perhaps unnecessarily liberal capacity. There appears to be in fact great diversity of practice in this respect.

Disadvantages of Operating Without Elevated Storage.—There are many disadvantages, particularly in the relatively small plant, of operating without elevated storage. The principal disadvantages are the following:

1—With direct pumping, it is necessary in order to maintain pressure to keep the pumps in operation at all times, at a rate equal to the demand. Interruption in power or other failure of pumps or supply at once results in an abrupt pressure drop and cessation of service. This result is always a severe inconvenience and may in case of fire be disastrous.

2—The necessity of following the demand curve with the pumps requires more consistent attendance at the pumps, especially with steam equipment, and does not permit of as good economy as would be possible by operating pumps of the proper capacity at their best efficiency.

3—From the standpoint of good pressure on the distribution system, following the demand curve with the pumps has a disadvantage in that at high pumpage rates, the friction losses between the pumps and consumers necessarily result in lowered pressure. It follows that satisfactory pressures are easily maintained on the distribution system at night and during the early morning hours of low pumpage when not so important, whereas pressures are necessarily less satisfactory during the hours when water is used at a high rate and good pressures would be particularly desirable.

4—With electric pumping, following the demand curve has the further disadvantage of building up a high peak power demand with corresponding unfavorable effect on the power bill. Direct pumping also precludes taking advantage of off-peak power rates, which usually involve a substantial saving.

Purpose of Elevated Storage.—Part or all of these objections to pumping direct may be obviated by elevated storage, the purposes of which may be summarized as follows:

1—To tide over interruption in pumping.

2—To smooth out peaks in demand, both for water and power.

3—For fire protection.

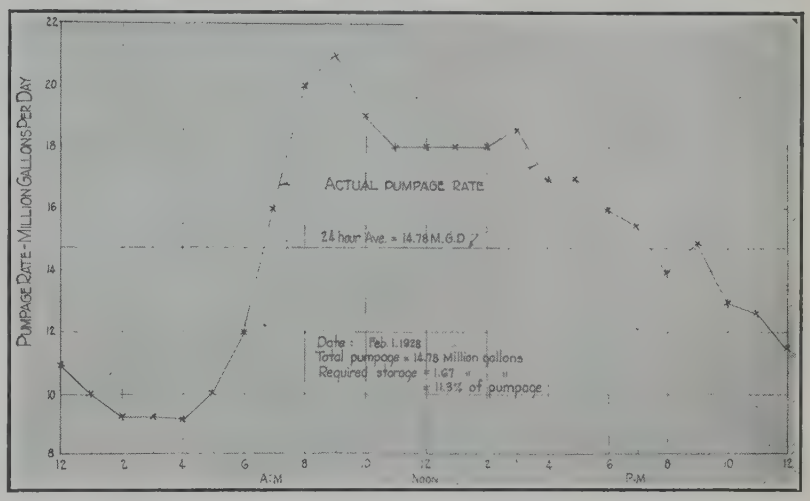


Fig. 1.—Pumpage Characteristics on Typical Approximate Average Day

4—To improve pressures.

Capacity of Elevated Storage.—The requirements for the above purposes vary widely with the size and type of plant.

In the small town a single elevated tank of moderate capacity may serve all of the above purposes economically.

In the larger plant, it may be better economy to provide a portion only of the desirable reserve as elevated storage. In very large plants, with steam operation and more than one pumping station, elevated storage becomes of less importance for reserve, but even here may be distinctly valuable to improve pressure distribution. The first step to a rational solution is a consideration of the proper basis for determining the storage capacity to meet each of the purposes listed above.

Tiding Over Interruptions in Pumping.—To meet the contingency of power interruption, the elevated storage

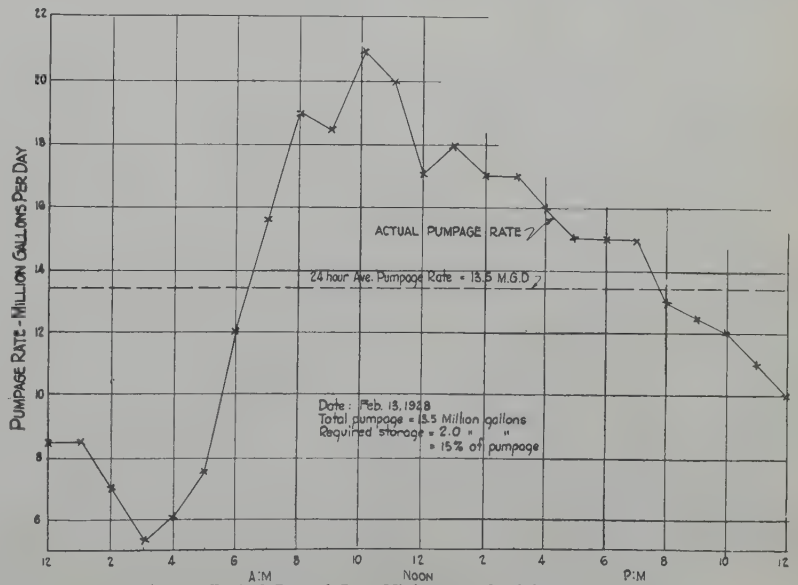

PUMPAGE RATE - MILLION GALLONS PER DAY
ACTUAL PUMPAGE RATE
24 hour Ave. Pumpage Rate = 13.5 M.G.D.
Date: Feb. 13, 1928
Total pumpage = 13.5 Million gallons
Required storage = 2.0 " "
= 15% of pumpage
A.M
Noon
P.M

Fig. 2.—Typical Day of Low Minimum and High Peak Average

should be sufficient to supply the ordinary consumption demands in the interval required for starting the emergency equipment. With electric pumping, this requirement is the minimum that should be provided. Preferably the storage should be extended when practicable so as to reduce dependence on stand-by pumping equipment.

Smoothing Out Peaks With Elevated Storage.—For the purpose of smoothing out the peaks in consumption demand, the required amount of elevated storage is approximately 15 per cent of the 24-hour pumpage rate, in fully metered towns with an average consumption of approximately 100 gal. per capita per day. This will vary with the pumpage characteristics of the particular plant and should be determined in relation thereto. Fig. 1, 2 and 3 illustrate the characteristics in a manufacturing city of about 160,000 population.

Figure 1 represents a typical approximately average day.

Figure 2 shows a typical day of low minimum and high peak pumpage. This shows a minimum rate of 5.3 m.g.d. and a maximum rate of 20.9 m.g.d., the maximum being nearly 400 per cent of the minimum rate.

Figure 3 shows three typical days of heavy pumpage.

On each of these diagrams there is indicated the elevated shortage required to permit the pumps to supply the demand at a uniform pumpage rate.

Leaving out of consideration future growth, the desirable amount of storage is this instance to make uniform pumping practicable is approximately 2 million gal., or about 15 per cent of the 24-hr. pumpage rate.

Smoothing out peaks of the pumpage rate has the following advantage:

1—In connection with electric pumping, it reduces the cost of power by lowering the peak rate of power demand.

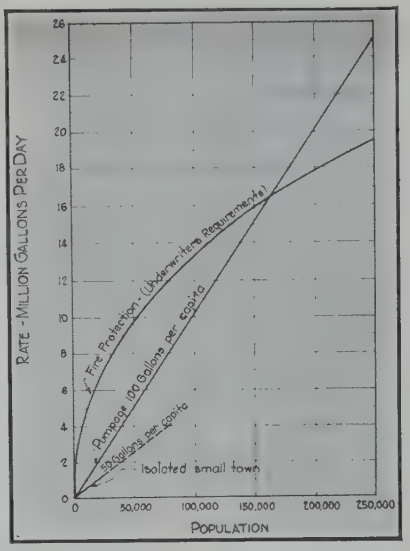


Fig. 3.—Three Typical Days of Heavy Pumpag

2—It reduces the cost of power, whether steam or electric, by permitting operation of properly selected units at maximum efficiency.

3—It increases the efficiency of the distribution system, permitting more uniform pressures to be maintained and providing higher pressures than otherwise possible during peak periods of consumption.

Off-Peak Pumping.—In plants operating on electric power, including cities with suitable high service reservoir sites as well as smaller towns, it may be good economy to include in elevated storage sufficient capacity allowance for shut down of pumps during the on-peak power hours.

Storage for Fire Protection.—In the small plant pumpage rates for fire protection are high relative to the average pumpage for ordinary consumption. This is clearly shown on Fig. 4, which shows the maximum fire demand rate in comparison with ordinary consumption rates, based on 50 gal. and 100 gal. per capita respectively.

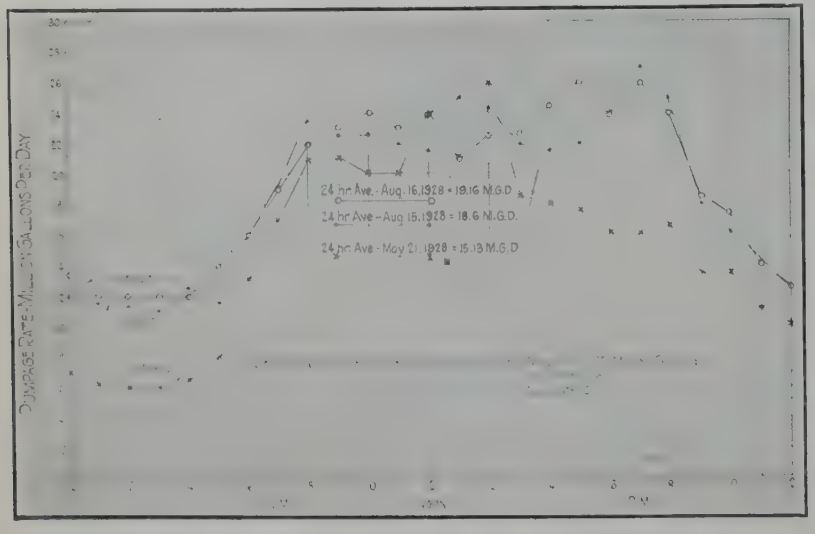


Fig. 4.—Maximum Fire Demand Rate Compared with Ordinary Consumption Rates.

The small plant with a well supply usually cannot furnish the quantity required for fire protection economically, except from storage. In such plants having air lift and in small plants with filtration, a large part of the necessary reserve is frequently carried as low level storage, but this has the disadvantage of too great dependence on pumps and power service, in emergency.

It is practicable in the small plant, and more satisfactory to provide all or a major part of the necessary reserve as elevated storage. This also applies to cities, which have suitable high level reservoir sites.

The storage capacity provided for fire protection should preferably be sufficient to supply the rate of flow called for by the underwriters' requirements, for 10 hours in cities over 2,500 population, and for 5 hours in cities under this population.

Depth of Storage.—Depth of storage should not exceed the permissable pressure variation. Storage below the level corresponding to the minimum pressures maintained, is wasted except as it may be of some value in extreme emergency. Such storage may not entail added cost but where not used is misleading if considered as useful storage.

Location of Elevated Storage.—Elevated storage may be utilized to improve the efficiency of the distribution system, and give better distribution of pressures. This purpose is best served by locating such storage remote from the pumps, and generally speaking, on the opposite side of the principal district served. In this way heavy drafts at intermediate points are supplied from opposite directions, thereby greatly reducing the pressure losses for given flows and correspondingly improving the pressures. To illustrate, if the flow is supplied at a point midway between pumps and elevated storage equal quantities being supplied from each source, the pressure loss at the point of use will be only one-quarter of the corresponding loss if the entire flow is furnished directly from the pumps.

Provision for Future Growth.—Provision of elevated storage should be made adequate for at least ten years in the future, just as would be done with any other major plant improvement. For this purpose, the trend of growth in pumpage and the probable conditions at least ten years in the future should be taken into account.

Acknowledgment.—The foregoing is an abstract of a paper presented at the recent meeting of Rocky Mountain Section of the American Water Works Association.

City Planning As Related to the Smaller Cities

General Procedure and Related Legislation Outlined

By E. A. WOOD
City Planning Consultant, Dallas, Tex.

IN adopting a comprehensive program for its work the National Conference on City Planning has urged each American municipality to do three things: First, provide a city plan commission and office where the commission may take part in the city's administrative machinery; second, prepare and adopt an official city plan; third, secure public support for the administration of the official plan. Such a program may be adapted to any municipality irrespective of size, location or composition. It also clearly shows that the difference in city planning in large and small cities is one of size only. The principles are the same and legislation is equally necessary in either case. There is this difference however—that city planning is easier for the smaller cities to undertake; is more effective, and does not cost nearly so much as in the larger cities.

All cities should be as carefully planned as a modern railway terminal, a suspension bridge or a central lighting plant. But the planning should be done before the city is built. And it should be along regulatory lines before mistakes occur rather than through the corrective method after errors have been permitted. Therefore, if the official plan is prepared in advance of city growth, its enforcement becomes a matter of public support strengthened by the necessary rules and regulations to make it effective in all parts of the city.

Planning Commission First Step.—As pointed out by the National Conference on City Planning, the establishment of a city planning commission is the first step in the planning of a city. Since private property and property rights are involved, a commission is better able to deal with the public than the mayor and board of commissioners. The latter do not have the time to devote to the many problems that arise, nor are they politically free to treat the subject dispassionately. The planning commission should be created by a properly drawn ordinance to give the required official status. Preferably the ordinance should be patterned after "A Standard City Planning Enabling Act," as prepared and published by the United States Department of Commerce.

This act was prepared by an advisory committee whose members have each had many years of first-hand experience in coping with local planning problems, both as citizens and in connection with the leading national business, professional and civic groups which they represent. During the three years' work required to draft the act, the advisory committee made laborious researches into legal problems and consulted with expert planners, members of planning commissions, municipal officials and other interested persons throughout the country. The act, therefore, represents the very best city planning thought, is concise yet brief, and contains the necessary legal phraseology.

Enlist Public Interest.—The relationship of city planning to the smaller city should be real. It should create a lively interest on the part of every citizen. The membership of the planning commission should be carefully selected and should be composed of outstanding citizens who can devote a considerable amount of time to the study of physical conditions on the ground as well as to the numerous meetings that will be required with different groups of individuals. The memberships should be varied and since the plan is to be comprehensive and include all phases of city life, the public schools, park board, women's clubs, chamber of commerce and retail merchants should be represented along with other organizations. Representatives from the city government should be limited to a member of the council and the city engineer. The former should act as a liason agent between the council and the planning commission, and the latter is entitled to membership by virtue of his office. He is also charged with the execution of the plan and to some extent with the enforcement of the commission's rules and regulations. The mayor and city attorney should be members ex-officio, the mayor by virtue of being the head of the council, and the city attorney by reason of his legal training.

The ordinance creating the city planning commission should also establish a budget to provide for the establishment of a city planning office, and the employment of a city planning consultant. The former is necessary to provide working quarters for the commission, a meeting place and a forum for the creation of interest in the official plan. Public interest in the plan is of prime importance, and it is necessary that someone explain the plan, exhibit maps and discuss advantages both pro and con if public interest is to be sustained. Many people respond by giving counter proposals, and thus interest is aroused and held if the work progresses expeditiously. In the smaller city, it is easier to create this interest and hold it because the diversity of objectives common to the big city is lacking. Also, the opportunities for correct planning are more numerous in the smaller city; at least the physical boundaries are more elastic and are more readily molded into the official plan.

Master Plan Essential.—But one must ever be on the alert for mistakes. Therefore, a city planning consultant should be employed, not only to guide and direct the planning, but also to serve as mentor to the city planning commission and the citizens. It is very easy to make mistakes, and early enthusiasm for city planning benefits may lead to serious errors unless held in check by the consultant. The making of a master plan is a matter involving not only all of the land within the city boundaries, but affecting all of the land adjacent to the limits. Therefore, study of an area larger than the city is necessary for the preparation of the master plan.

After the city planning commission has been established and before work has been started on the master plan, there are a number of city planning regulations that may be put into effect. The most important of these are the platting requirements and the zoning ordinance. An early enactment of the platting rules is very desirable because of the failure of individual land owners to coordinate their subdivisions with existing streets, alleys and blocks. This is not due so much to willful neglect as to the lack of foresight and the absence of a master plan to serve as a guide. Coordination of all plans is the outstanding feature of a master plan.

Platting of Property.—The planning commission should prepare and adopt a set of rules governing the platting of property at its earliest opportunity, so that it can exercise the necessary supervision over the individual property owners and coordinate individual efforts. These rules should lay down clearly and concisely the kind of plats to be submitted for approval, together with the scale of the drawing and the information desired. It is necessary that a certificate of ownership be furnished together with ties to existing corners, to locate the property on the master plan. Such rules acquaint the public with the commission's function and methods. To be effective they should also be adopted by the city commission. This gives them legal status.

In Texas, cities of 25,000 population and over now have the power to control platting, not only within the city's

limits, but also for a distance of five miles beyond. In cities of less than 25,000 population, control within the city limits can be obtained by withholding water, sewer or other utility connections until plats conform to the master plan. Continuous streets of proper width without offsets and without dead ends and with blocks of economical size can thus be secured and the plan gradually carried out.

Develop Parks; Preserve Trees.—Additional features might be added to these regulations which would be helpful to the master plan. These are building lines for residences, setbacks for stores adjacent to home areas and the dedication of fractional lots for park purposes. Certain cities now require property owners to dedicate 10 per cent of their additions for park purposes to assist in the development of a park and playground system.

Parkways, boulevards and walkways should be located along creeks and rivulets. The parkway feature is extremely important because it not only furnishes an adeqaute storm sewer system but also adds to the beauty and utility of additions, spreads out the population and reduces the danger from fire. Too frequently this type of regulation is overlooked and subdividers are permitted to fill up dry runs and storm channels, including these in the lots and selling to private owners who have no interest in maintaining them as public ways.

Trees and shrubs are usually found along such channels. These should be preserved as an asset to the city not only from the aesthetic standpoint but also from the utilitarian standpoint of shade and playground space. Natural beauty spots can rarely be improved upon except by cutting out underbrush and making them available to the public.

Establish Building Lines.—The establishment of building lines in residential districts adds materially to the privacy of homes, decreases the dust nuisance, decreases the noise from passing traffic and encourages home beautification through the planting of grass, trees, flowers and shrubs. They decrease the accident hazard to children by providing suitable playgrounds on every lot. They also permit vision clearance for traffic at street intersections.

In suburban and outlying business districts the building line or "setback" permits cars to park "head-in." This gives greater freedom to traffic. It not only removes the parked vehicles from the moving lanes of traffic but also provides for future street widening.

Zoning Ordinance a Prime Requisite.—Zoning regulations should also be enacted before the preparation of the master plan. These deal with the use of private property and not only restrict the ues of the land, but also limit the height of buildings and the density of population. Three general types of usage are recognized in zoning regulations; viz., residential, commercial and industrial—the former being the most restricted use while the last is the least restricted.

In the early days of city life property classifies itself along economic lines and following certain economic laws. Industries and warehouses are established along the railways, while the banks, hotels and stores form a group around the public square. Beyond the stores are the homes of the people. Zoning follows these same laws and prohibits the intermingling of industry, commerce and dwellings. Homes may be built in commercial or industrial districts but commerce or industry can not invade home districts nor can industries invade business districts.

This type of regulation is legal not only in Texas but in the majority of the states because it is based upon the police power of the government which seeks to protect the health, safety, morals and general welfare of the community. This authority was given to Texas cities by its legislature in 1927.

Zoning regulations are meeting a popular demand on the part of home owners for protection. This popularity is shown by the following table showing the number and class of cities in the United States having zoning regulations.

Population	No.
Less than 1,000	53
1,000 to 5,000	144
5,000 to 10,000	102
10,000 to 25,000	103
25,000 to 50,000	79
50,000 to 100,000	47
Over 100,000	55
Total	583

Zoning is an essential part of the master plan. Land is divided into two general classes: public land and private land. The master plan must deal with both classes and unless some measure of control is exerted over the privately owned land, correct city planning cannot be had nor can proper provision be made for the expansion of streets and public utilities.

Once the character of the various sections of the city is established by zoning, the street plan, the park, boulevard and playground sytem, the school locations and the civic center can be designed and laid out as an integral part of the master plan which gives the picture of the future city. Of course it will need to be expanded from time to time and even supplemented or changed. Nor will the work of the city plan commission ever be finished. It will continue from one year to the next, attempting to provide plans in advance of actual growth.

Public Must Favor Plan.—Public support is necessary for any city plan and the master plan must be sold to the public, else it will never be carried out. Experience in many cities bears out this statement and it is sometimes said that it is better to have more selling and less planning. At any rate, the essential point is to sell the community on the advantages of planning and a master plan. Citizens will then demand the plan before they will permit the expenditure of public funds for uncoordinated work. This is particularly true of the smaller cities whose public funds are limited.

Acknowledgment.—The foregoing is a paper presented at the spring meeting of the American Society of Civil Engineers at Dallas, Tex., on April 25.

The Planning Foundation of America

When the movement for better city planning began to gather headway in the 1900's, the needs and problems of the cities' congested populations and movement were recognized as appalling enough to demand the establishment of a central forum for their discussion and formulation. In 1910 the National Conference on City Planning was organized. As the planning interests of the country expanded, the Conference became the center for research, advice and information to the extent of its limited financial resources.

But there is no easy solution for these grave municipal problems, and the necessity for an adequately equipped central organization devoted solely to the study and guidance of city and regional planning in the United States has been increasingly apparent. Frederick J. Keppel, president of the Carnegie Corporation, in his annual report for 1928, points out that each year's experience "reinforces the conviction that additional foundations are needed, particularly of relatively limited objective, and not necessarily of large capitalization;" and quoting from his annual report of 1926, Mr. Keppel specifies among other requirements studies in rural life, in recreation, and in town and regional planning.

It was proposed, therefore, in 1928, to erect a Planning Foundation to expand the service program already operated by the Conference, and with the larger resources of such a foundation increase the service of the Conference in proportion to the planning needs of the country.

The Planning Foundation of America will not teach people how to pave streets or build private houses and city halls. It will not instruct them how to finance the acquirements of parks, or the enlargement of water supply systems. Capable agencies exist for these purposes. The Foundation's object is to bring together the facts, figures and experiences of city and regional planning, wherever they exist, study them, coordinate them, and place them at the disposal of the public as authoritative planning guides. When the problems of city planning are so treated the movement for orderly city growth will reach its goal on a sound economical basis.

New Safety Zones Protect Pedestrians and Trolley Passengers in Toronto

Electric Beacons of Unusual Design Installed

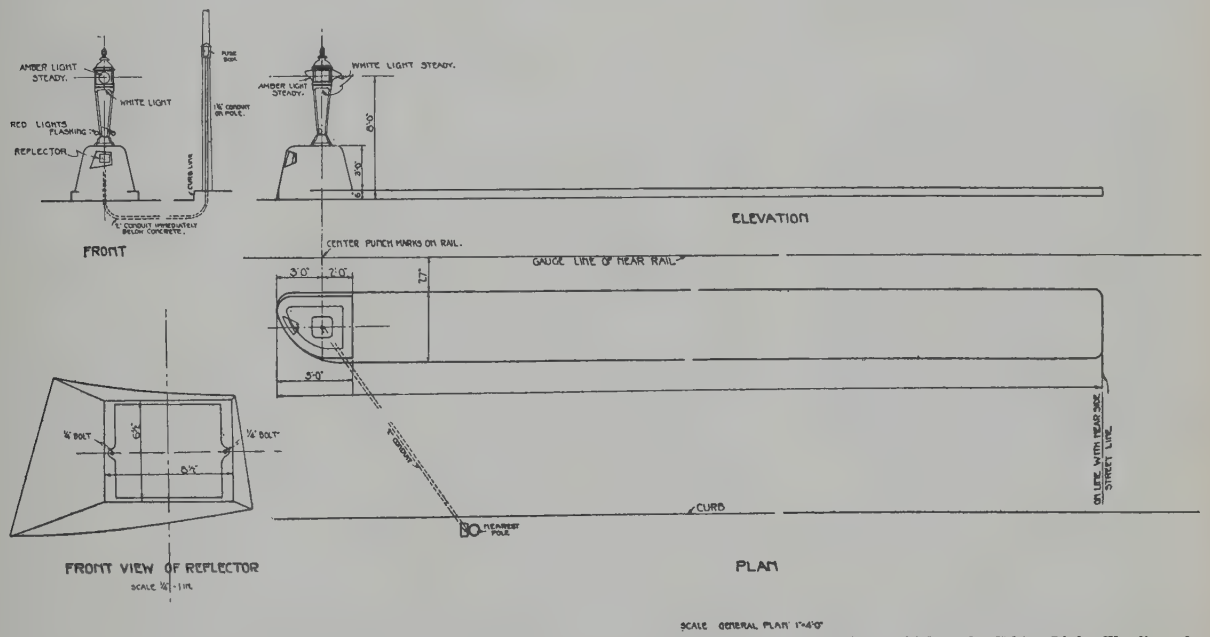
A RECENT contribution to the safety of pedestrians and street car passengers in Toronto, Ont., is the system of safety zones installed on St. Clair Ave., between Bathurst and Dufferin streets. The installation of beacons and concrete loading platforms has been a decided success, according to H. W. Tate, Assistant Manager of the Toronto Transportation Commission, who furnished the information here presented.

City, Commission Divide Cost.—In the latter part of 1928 the Toronto Transportation Commission reconstructed 1¼ miles of double track on St. Clair Ave. with its standard paved construction, where previously there had been open tracks and a boulevard strip. At this time an agreement was entered into by the city and the commission, providing for the construction of safety zones at the various car stops within the reconstructed section by the city, and furnishing and maintenance of lighting beacons by the commission. Under this arrangement 20 safety zones were constructed, the commission furnishing the city with the design of platform and buttress.

Design of Zones Based on Tests.—The original design called for an overall length of platform of 105 ft., to accommodate the standard length of train operated, but this dimension was shortened to 55 ft. by the city. A width of 4 ft. 6 in. and a height of 6 in. above the adjoining pavement were decided upon after a careful study of safety zone installations in a number of American cities. A distance of 2 ft. 3 in. from the near rail to the face of the platform gives proper clearance for the rolling stock operated by the commission.

Tests were made using a dummy platform, to insure that the clearance distance of 2 ft. 3 in. and the height of 6 in. above the pavement in no way interfered with the speed of loading and unloading and that no risks to passengers were introduced in these operations. The accompanying drawing shows the location and dimensions of the zones.

Construction of Beacon.—The beacon frame consists of a cast-aluminum housing, mounted on four tubular supports which are bolted to the concrete base. Three distinct optical units are provided in the beacon: one to attract the attention of oncoming traffic, one to light the loading platform and one to illuminate the concrete buttress at the base of the beacon pedestal. The aluminum housing contains these three units as well as a flashing motor. Doors are provided to give access to the units within. The height from the top of the concrete pedestal on which the beacon is mounted to the center of the lens is 4 ft. 6 in. At the base of the beacon are arranged two ruby globes, protected by guards and connected to the flashing motor. A red glass reflector is installed in the front of the concrete buttress as an additional safeguard in the event of a failure of the lighting supply.



New Safety Zone of the Toronto Transportation Commission. Notice the Amber Light Facing Oncoming Vehicles, the White Light Flooding the Loading Platform, the White Light Illuminating the Concrete Buttress and the Red Flashing Lights

Three-Purpose Optical System.—The optical units installed in the housing utilize two side faces and the bottom of the casting, and operate on a steady current.

For oncoming traffic there is provided a square condensing refraction amber lens having an illuminated area of 8x8 in. For lighting, a lamp of from 60 to 100-watt size is utilized. The lens is capable of distributing the light laterally over a wide angle. A visor is provided.

The system used for floodlighting the platform is placed on the opposite side of the beacon from the amber lens. A round lens of clear prismatic glass, 8⅜ in. in diameter, is employed. Illumination is provided by a 60-watt traffic signal lamp and a parabolic reflector. This entire system is rendered dustproof and weatherproof by means of rubber gaskets.

The concrete buttress supporting the beacon pedestal is illuminated through a lens in the bottom of the housing. This unit is essentially of the same arrangement as the unit used for floodlighting the platform, utilizing a square refraction round lens, gasketed into the bottom of the housing.

Beacon on Two Lighting Circuits.—The lighting units in the aluminum housing are on the street lighting circuit, while the two flashing lights mounted near the base of the pedestal

How the Beacon Appears to Oncoming Vehicles. The Ruby Globes Near the Base of the Pedestal Flash Continuously and the Red Glass Reflector in the Concrete Buttress Is an Additional Safeguard in the Event of a Failure of the Lighting Supply

are on a commercial circuit, allowing continuous operation. The flashing mechanism consists of a small 110-volt motor, with attached switch of the mercury tube type. The ruby globes flash once a second. The beacon is connected to the nearest curb pole by a 2-in. conduit carrying lead-covered cable, laid under the roadway. The beacons were supplied by the Canadian General Electric Co.

Cost of Installation and Maintenance.—The cost of each zone, complete with beacons, was approximately $700. It is believed, however, that future installations will not cost more than $600, as a number of development charges were included in the first cost. The cost of lighting will be about $1.50 per month and the cost of electrical maintenance $1.00 per month, making a monthly charge of $2.50 per zone.

Installation Pleases Public. — The zones have received many favorable comments and are freely used by pedestrians crossing from one side of the street to the other as well as by the car passengers. Vehicular traffic is allowed to proceed with caution past the zone while a car is loading and unloading and, as no curb parking is allowed opposite the zone, there is no doubt that vehicular traffic is speeded up.

Costs of Refuse Disposal by Various Methods

The cost of any particular method of refuse disposal varies greatly with the composition of the refuse and such local conditions as labor prices and the market for waste products. Some unit costs are given below as an indication of what has been done under various methods of disposal. These figures are reprinted from the advance proof sheets of a report of the Committee on Regional Plan of New York and Its Environs.

Feeding to Swine.—The operating cost of the Worcester, Massachusetts, hog farm was $2.65 per ton of garbage in 1917. The return from the sale of hogs was at the rate of $6.85 per ton of garbage, yielding a profit of $4.20 per ton. The city of Los Angeles, Cal., under its contract entered into in 1921, receives $0.60 per ton of garbage after loading on railroad cars.

Dumping at Sea.—The cost to New York City of dumping garbage at sea after loading at the waterfront dumps was about 15 ct. per cubic yard in 1924. There were 494 tows handled that year and the dumping ground was about 42 miles from the Battery during the summer months and several miles nearer during the winter.*

Garbage Reduction. — In Rochester, N. Y., 34,700 tons of garbage were treated during 1925 by the Cobwell reduction process, at a total cost, including operation and capital charges, of $9 per ton. By-products produced a revenue of $6 per ton, making a net cost of $3 per ton. Excluding capital charges, this amounted to $1.55 per ton net cost which it was hoped to reduce to $0.75 in 1926.†

The Cleveland, O., reduction plant, which averaged $1.70 per ton profit between 1915 and 1920, has been particularly successful. It shows the possibilities of this method under favorable circumstances and efficient operation. From 1921 to 1926 this plant operated at a loss, due to comparatively low prices received for grease and the high rate of wages paid. In 1926 this loss amounted to only 13 ct. per ton. These figures all include depreciation but no capital charges.

Incineration.—Statistics for 1925 for incinerating plants of Toronto, Can., indicated a total operating costs, less carrying charges, of $1.50 per ton, at a plant which handled about 50,000 tons annually of mixed garbage and rubbish, and $1.11 per ton at another plant handling about 63,000 tons.‡ An incinerator constructed in Buffalo, N. Y., in 1926, has been handling about 360 tons daily at a cost of $1.61 per ton.

To decrease the cost of incineration it is interesting to analyze the possibilities of the generation of steam. A modern high temperature destructor will furnish sufficient heat for the evaporation of 1 to 2 lb. of water per pound of refuse burned, depending upon the composition of the materials, in addition to any preheating of air required for the furnace operation. One ton of mixed garbage and rubbish per hour should generate 1,750 lb. of steam, or about 50 boiler horsepower. Assuming generator efficiency of 87 per cent, the developed horsepower would be 44.5 per hour or 33.2 kilowatts per hour. For a 200-ton plant on a yearly basis this would be 50,000 tons×33.2=1,660,000 kilowatt-hours. Electricity could be sold at approximately 1 ct. per kilowatt-hour or $16,600 per annum. If the electricity could be utilized for lighting and general purposes in New York City municipal buildings, it would save a present expense of approximately 5.40 ct. per kilowatt-hour, or $89,500.

The first basis, i. e., incineration without production of steam, would give an estimated 1925 unit cost of incineration of $2.36 per ton of garbage and rubbish. With production of steam on the basis outlined above, the unit cost of incineration would be $0.57 per ton of garbage and refuse.

Itemized costs have been computed based on labor charges obtained for certain incineration plants in New York City in 1925. For a 150-ton plant, handling 110 tons of refuse per day, the following labor was required:

1 Stationary engineer at $8.50 per diem	$ 8.50
6 Firemen at $6.50 per diem	39.00
3 Garbage Stokers at $5.50 per diem	16.50
2 Ash pickers at $5.00 per diem	10.00
2 Watchmen at $5.00 per diem	10.00
Total labor cost of disposal of 110 tons of refuse	$84.00
Labor cost of disposal per ton of refuse	.76

Similar figures for a 100-ton plant, handling 75 tons of refuse, showed a labor cost of $0.74 per ton of refuse. Taking into consideration all items of operation and maintenance, the following approximate subdivision of cost per ton was obtained:

Labor	$0.76
Other maintenance and operation costs	.06
Interest on investment at 6 per cent	.60
Amortization	.24
Depreciation	.24
Total cost per ton	$1.90

Beccari Method.—It has been estimated that the cost per ton under the Beccari method of disposal would be about $1.13. If a market should exist for the residual humus, this treatment might be expected to yield a profit.

*Mr. Kenneth Allen, Transactions, American Society of Civil Engineers, Vol. 91 (1927), page 839.
†Mr. John V. Lewis, ibid., pages 828 to 836.
‡Mr. J. A. Burnett, ibid., page 827.

The Maintenance of Small Water Meters

Important Features and Methods Used at Hartford

By H. W. GRISWOLD
Designing Engineer, Board of Water Commissioners, Hartford, Conn.

THE maintenance of its meters is always a live problem with the management of every water utility, and as the number of its meters and the cost of their maintenance increases, it becomes more and more important to so conduct the business that, on the one hand, too much revenue is not lost from out-of-repair meters, and that, on the other hand, too much is not spent on the upkeep of the meters themselves. Many factors must be considered in deciding upon a meter maintenance policy which will be balanced properly between these two extremes, which will meet the requirements of the public utility commission or other supervisory body, and will not produce an undue number of complaints from customers.

The First Item of Maintenance.—Meter maintenance really begins with the uncrating of the meter at the utility receiving room for the methods of handling as well as the type and kind of setting have considerable influence on the subsequent performance of the instrument. Rough handling and exposure to extremes of heat or cold are not good for any make of meter and are to be avoided always. Some utilities make a flow test on new meters before putting them into stock or into service. This serves not only as a check on the manufacturer's product but detects any meters that may have been damaged in transit or after delivery.

Setting Meters.—In setting meters two general methods are followed. One is to set the meter in the cellar of the building served as close to the point of entry of the service pipe as possible. The other is to set the meter in a box or vault at the street line. Which is the better form of setting depends on climatic conditions—how often the meter is to be read—against whom the cost of the meter setting is assessed—the length and kind of pipe serving the building—and the type of building. With either type of setting brass tail pieces or one of the numerous patented types of settings may be used. At Hartford, most of the settings are in the cellars of buildings, and all new meters are tested before being set.

Meter Costs at Hartford.—The costs of the different operations for the various sizes of meters are tabulated below.

The cost of the meter and all of the meter costs incurred up to and including the first setting are properly chargeable to capital outlay, so that from an accounting standpoint, maintenance costs may be said to start as the meter setting team drives away.

Many Ramifications of Maintenance Problem.—The problem of meter maintenance has a great many interesting ramifications and it is interlocked to a greater or less extent with practically all of the other activities of the utility, but, considered alone, the most efficient method of maintenance is the one which gives a minimum sum for the cost of keeping a meter in operating condition on each service, plus the value—at the established rates—of the water which passes through the meters unregistered. The maintenance cost item in turn is the sum of the costs of the various kinds of work that go to make up the job of meter maintenance, and of these operations, some must be performed regardless of cost, while others may be curtailed or extended as desired or as funds permit.

Repairing and Changing Meters.—A large part of the work and a part that must be carried on continually, is the changing and repairing of meters reported as "Down" or "Not Operating" by the meter reading or inspection force. The stoppage of the meter may be due to plugging with rust or some other foreign substance, to mechanical trouble in the meter or injury from freezing or from hot water. To remedy the trouble from any of these causes the meter must be removed from the service and taken to the shop for repairs. At Hartford a crew of two men with a light car are used for changing meters. For many years it was the custom to take off a meter, put a pipe nipple in its place, and when the meter had been repaired at the shop to make a second trip to put the same meter back on the service from which it had been taken. During the last year or two it has become the practice to take off a "down" meter and immediately to put on a new or repaired meter in its place from a small stock carried on the meter truck. This saves the second trip to the service and while it increases the clerical work somewhat, the net result has been a reduction in cost.

Shop Procedure.—In the shop, two methods of procedure seem to be in general use. In the smaller shops one man does the whole work of repairing and testing a meter. In the larger shops one man cleans and dissembles the meter; a second inspects it, decides what repair parts are needed and requisitions them from the stock room; a third man assembled the meter with the new parts and adjusts it; a fourth man tests it, and a fifth man paints it and makes it ready for the stock room or for setting. This procedure follows in general the standard factory method of splitting up a task into a number of operations of which the individual worker performs but one. Some shops replace gear trains and registers as units and have one or more men whose job it is to repair these parts only.

Stock Room Practice.—A stock of parts for each make of meter to be repaired at the shop must be carried, and the tendency is for this stock to grow unduly large if not carefully controlled. Where only a few meters of one make are in use, it is sometimes cheaper to carry no parts for them but to ship the meters of this make to be repaired back to the factory. The stock room practice usually follows that in use for the withdrawal of other material than meter parts from stores although some utilities do not keep a stock ledger for meter parts and do keep a ledger for main pipe and service pipe material. It is true of course that a meter stock consists of a great number of very small parts having a low price per unit and that the clerical work necessary to carry on a complete stores account for meter parts is a much larger percentage of the value of the stores than is the case with either main pipe or service pipe supplies.

Meter Testing.—In testing either new

Meter Costs for 1928 at Hartford, Conn.

Size—	⅝ in. Per Meter	¾ in. Per Meter	1 in. Per Meter	1½ in. Per Meter	2 in. Per Meter
Testing new meters	$ .29	$ .31	$ .56	$ .52	$ 4.25
Installing in buildings	3.37	3.84	4.84	8.41	9.30
Changing in buildings	1.35	1.50	1.38	3.36	8.11
Repairs and test (used meters)	4.45	5.20	7.81	12.30	18.40
Building Meters:					
Installing	3.95	.....	.....	.....	.....
Replace with permanent meter and repair and test building meter	10.04	.....	.....	.....	.....
Number of Meters Handled					
New meters tested	275	400	78	50	3
Installed (new) building	241	300	52	40	5
Box	21	25	6	.....	.....
Changed in buildings	753	745	187	25	21
Used meters repaired	914	843	213	31	30
Building meters	517	.....	.....	.....	.....

or repaired meters one of the several makes of meter testing machines is very generally used together with the necessary tanks and scales for determining accurately the quantity of water passed by the meter. A machine which tests one meter at a time usually suffices for a small shop but as soon as more than three or four are working on the repair of meters a machine that will test meters in groups of from five to eight is found to be more satisfactory.

Meter Records.—Meter records are an essential part of any successful scheme of meter maintenance, but the cost of these is apt to mount along with the stock room costs if not watched. Records, no matter how interesting, which are not summarized at frequent intervals nor used regularly in the conduct of the business should be viewed with a critical eye. No system can function without some form of work order, which is often made to serve as a report of the job when completed. All meter work must be reported in detail to the meter reading department in order that the meter readers' books and the consumers' ledger may be kept straight and up to date, for it is on these in the last analysis that the utility depends for its income—the most important thing in many ways in the whole business. Whether it pays to keep a record of the kind, number and size of meter on each service or to keep a history card for each meter on which is noted all its goings and comings, the amount of water it has passed to date, all the tests that have been made on it and the cost in detail of each operation, are questions which have as many different answers as there are utilities. These meter life histories are interesting to study, but from an operating standpoint it would hardly seem worth while to keep such close track of a $10 to $15 article unless such records would pay for themselves in pointing the way to economies in maintenance or in determining the most efficient make of meter to purchase. The latter use of the history is the one most often stressed, but it is doubtful if many meters are actually purchased on the strength of the records made by the early—and now obsolete—models of that make of meter.

Minor Meter Repairs.—There are certain repairs that can be made without removing the meter from the service. Chief among these are stuffing box leaks and the replacement of the register glass cover. By having the meter readers note the nature of the trouble in reporting a meter "down" it is possible to have these repairs in place taken care of by one man with a light car to take him from job to job, and thus a large part of the expense of taking off and replacing the meter is avoided.

Meter Reading. — The frequency of reading meters is a factor to be reckoned with in meter maintenance. The cost of reading meters for billing purposes alone is not properly a maintenance charge, but often meters are read one or more times between billing dates for the dual purpose of detecting "down" meters and of locating meters which show excessive consumption so that the owners of the property may be notified and may either take steps to stop the excessive use or waste or be prepared for an unusually large bill at the end of the period. The cost of these intermediate readings is in part at least chargeable to meter maintenance and if the interval between readings is short enough it will be unnecessary to make additional inspections of small meters in place. In Hartford the small meters are read every two months and the bills sent out every six months. Large meters are read and billed monthly. Interesting data on the current practice regarding meter readers and meter reading in other southern New England cities are shown in the tabulation.

Data on Meter Readers and Meter Reading in Southern New England Cities

Number of Meters	How Often Read	No. of Readers	Hours Worked Week	Rate of Pay	Meters Read per Man	Other Work Done
5,490	3 mo	2	44	$30 wk	100	Remove and Reset
7,560	big 1 mo sml 3 mo	10 { 4 6	54	$32 wk	75-90	Inspect Leaks
9,480	3 mo	3	44	$5.75 d	60	None
9,950	Abt 45 d	3	44	$32 wk	90	None
13,980	Hse 3 mo Com 1 mo Big 1 wk	4	48	$5.04 5.36 d	125	None
15,390	big 1 mo sml 1.5 m	---	41.5	$5.00 d	50	None
22,000	1½ mo	6	41.5	$38 wk	100	Inspect Leaks
22,400	big 1 mo sml 3 mo	8	44	$36	90	Inspect for Meter Repairs
24,110	big 1 mo sml 3 mo	6	44	$30 wk	90-100	None
27,662	Monthly	10	40	$42	100	None
41,276	3 mo	10	44	$24-$30	85	Inspect
96,460	big 1 mo sml 3 mo	31	38	$25-34	49	None

It seems to be generally conceded that meters, even though they are apparently operating perfectly, should be removed, tested and repaired at intervals in order to keep them within reasonable limits of accuracy. In some states—Connecticut among them—this interval is determined by a ruling of the Public Utilities Commission or similar regulatory body, and varies from about five to ten years. The lower figure is for Connecticut and the higher for New Jersey. In some cases the maximum quantity of water that shall be passed by a meter between regular tests as well as the time interval between tests is specified. For any utility not covered by a definite ruling regarding regular tests, the proper interval between tests could be determined from the costs of changing and repairing a meter, the rate charged for water, and data on the average performance of the makes of meters in use in the community over a period of years. The first two items are known or can be readily ascertained but even where meter histories are kept it is not easy to construct a performance curve that will be truly representative. Factory tests show that a meter may register on a 1/32-in. stream after passing a million cubic feet of water. In general, however, it may be said that meters do not register more water than passes through them—consumers to the contrary notwithstanding—and that the longer meters run the less accurate they are—the decrease in accuracy being a function both of the time in service and of the quantity of water passed.

Conclusion.—In conclusion, and as a summary, it may be said that the five factors which have the most effect on the cost and efficiency of small meter maintenance are:

1—Frequent inspection of meters in service to detect those not registering and those over-registering.

2—The prompt removal and replacement of "down" meters with a minimum of lost motion.

3—The testing of all meters at regular intervals.

4—The application of efficient factory methods to the repair shop and the testing bench.

5—Close control over records and stock so that there will be enough—but not too much.

Acknowledgment.—The foregoing is an abstract of a paper presented April 10 at a spring meeting of the New England Water Works Association.

Minnesota Water Works Men Meet in June.—The next meeting of the Minnesota Section of the American Water Works Association is to be held jointly with the Minnesota League of Municipalities, June 12th to 14th, 1929, inclusive, at Austin, Minn. Secretary R. M. Finch, Wallace & Tiernan Co., 240 South 4th St., Minneapolis, Minn.

How to Secure Better Bituminous Macadam

The Importance of Watching Details in the Progress of the Work

By WILLIAM J. DOUGHERTY
Secretary-Engineer, Park Commission, Portland, Me.

IT may be of some interest to those who are engaged in building bituminous macadam, or who may, in the future, have this class of work to do, to offer some comment bearing on this type of construction which we are reasonably sure to have to construct in New England, at least, for some time to come. There is probably not one of the present accepted standard types of improved surfacing which has been more abused in construction, and which has varied so much in the degree of satisfaction attained as has this bituminous type. We can most certainly place a great deal of the trouble with, or the apparent shortcomings of this type of pavement, to that real enemy to good construction, the personal element or equation, if you like.

While the writer realizes full well that bituminous penetration construction cannot take it splace side by side on the economic scale with some of the really heavy duty pavements, such as reinforced concrete, sheet asphalt on concrete base and the stone block types, yet there is very much that can be offered to show that penetration macadam has an important role to fill in the development of any comprehensive highway system in New England and many times elsewhere.

Salvaging Old Roads. — The wisdom of salvaging many of the worn-out macadam roads and many times the seasoned and treated gravel roads which are the results of progressive road building steps and to make these serve as foundations for bituminous pavements has been stressed repeatedly in highway writings. It is this very factor of seasoned depth of good foundation material that should make us alert to the economy of surfacing the road with bituminous pavement. Penetration construction appears to be the recognized type for usage with foundations as above described. We should be very reluctant to "scrap" a very valuable base road, if there is possibility of restoring it and making it conform to the grades and contours of the new pavement.

The Personal Item.—The writer has at times noted a marked indifference on the part of some officials, charged with highway work, to put real heart into bituminous penetration construction to get all there is of value into the pavement and this when it is found that neither the traffic to be served nor the funds at hand warrant the selection of a more rigid and more expensive type. Mention of expense prompts me to say that under conditions often met in practice, bituminous penetration can cost considerably more than concrete pavement if you have to prepare an adequate base. Due to the necessity of deep base construction required ordinarily for bituminous macadam, by comparison to reduced thicknesses of bases (with just as much effectiveness) required for concrete pavements, it is many times wiser to accept the reinforced concrete pavement at a higher cost per square yard than to attempt a thoroughly new and adequate build-up for bituminous macadam. In short, it is when our predecessors in highway construction have bequeathed us something of real value that we should be alert to utilize to the very best advantage, former expenditures in base course construction.

To my way of thinking and from actual observation there are altogether too many so-called road builders entrusted to build this, as well as other types, who, either from a lack of knowledge of the details making for good construction, or else, from a standpoint of discounting in advance the merit of the pavement, fail to get real value received for the expenditures made.

Relative Importance of Bituminous Macadam.—As to the relative importance of bituminous macadam, it may be of interest to note that an article on "The Trend of Highway Design," May, 1927, Roads and Streets (the matter compiled by engineers of the Office of Public Roads) shows that bituminous macadam increased its popularity over previous years and it is presumed here that since the time of this article the popularity of this type has not waned.

View of Baxter Boulevard, Portland, Me., Showing Asphaltic Macadam Finished August, 1927 Start of Landscape Treatment Shown on Side. Slope to Sidewalk Will Be Planted with Flowering Shrubs

Of all Federal Aid road mileage completed by types to June 30th, 1926, bituminous macadam comprised 5.6 per cent and cement concrete pavements 20.3 per cent of the total mileage, but of the one year ending June 30th, 1926, bituminous macadam was 7.4 per cent of the mileage done while concrete was 24 per cent. This demonstrates that this type is still "in the picture," and if we are to do it, let's do it as well as we are able to do it.

The writer wishes to emphasize here that in his opinion bituminous macadam is much more difficult to construct in a thoroughly satisfactory manner than many of the other types of pavement in present use. Cement concrete pavements of today are constructed under most meticulous specifications for materials and methods and under careful field control and with the mechanical equipment at hand for uniform and speedy results and the exactitude required to have the surface conform by templates and finishing machines to the required even surface there is much less of the individual workman's skill re-

quired. With the recognized mixed types of asphaltic construction we have the laboratory control and the advantage of highly standardized gradings of aggregates, analyses of bitumen and many other helpful matters, but with bituminous macadam it is not practicable to control the construction by such clearly defined methods and, written specifications to the contrary, officials in charge of bituminous penetration construction many times find themselves somewhat at the mercy of the contractor for this kind of construction and his ability to value details, which add considerably to the merits of this type of construction.

View Showing 1928 Asphalt Macadam Construction at Hanson's Creek, Baxter Boulevard. A 48 Ft. Width of Newly Paved Surface. Note Coarse Texture of Finished Surface in Foreground, Also Slight Overlapping of Seal Application in Foreground and Small "Fat" Spots in Right Middle. These Are Slight Defects to Guard Against in Construction of This Kind

The Importance of Rolling.—For instance it is not general practice to "true" a surface of macadam pavement with a straight edge (although this has been tried in some sections of the country with varying success) and we must admit that surface irregularities of any consequence are incipient causes of failures in a pavement. Nor is it very practical to say, in a quantitative manner, in advance, the extent to which stone shall be rolled before penetration application, after penetration, and finally after seal coat. The two points mentioned may appear relatively unimportant to some, but to the writer, who has had considerable experience in this class of construction the matter of intelligent and adequate rolling is all important, and many times the lack of thorough compaction will spell disaster to the road under traffic. The quality of stone in the construction of bituminous pavement, being variable within accepted limits of wear tests, it remains to the engineer or inspector in charge to get as much compaction and interlocking of particles of the stone course before penetration as possible without serious crushing of the stone particles, with consequent choking of the voids and prevention of thorough penetration of bituminous material throughout the thickness of the wearing course.

Of course, stone acceptable for the wearing course should stand a reasonable amount of rolling, but many times we run into stone that varies on the work and if it is a case of withholding a measure of rolling, so as to insure thorough penetration of bituminous material, this should be done by all means. It is particularly after penetration that the writer would insist on most thorough rolling. It is extremely important that the operator roll and roll and then roll some more, and to do so, if possible, in the warmest part of the day. Let it be said that it is not always easy to get the present day road roller operator into the spirit of rolling such as described.

You will think that this is too much space to give to this one detail of this comment, but the writer has observed this point of construction to be a rather critical one in the success of bituminous macadam. At the point of surface irregularities it is quite obvious to most road builders that bumps and hollows cause trouble either by weaknesses arising out of impact of traffic or from freezing and thawing stresses to say nothing of the discomfort of riding. And since generally speaking we do not grade by template the coarse stone that is presently being used in this type of pavement, you can readily appreciate the care involved in getting a true and even road shape by the use of mechanical stone spreaders and some hand grading.

It facilitates greatly the matter of surface grading, as well as adding something very valuable to the construction, to have the base course of stone graded as nearly as practicable, parallel and uniformly below the finished surface and to have the base course finally compacted and tightened by the method of void filling by dry rolling (if possible) into the base all the screenings or sand (screenings preferred under dry weather conditions) that can be put in and yet leave a "toothy" surface to this course.

Thickness of Wearing Course.—As to the thickness of the "wearing" course of macadam, 3 in. seems to be the popular thickness and with the present practice of using stone passing a 2½ in. ring it would not seem sensible to have less than this thickness. While 5 in. is a popular thickness for base course, under exceptional conditions for foundations it would seem sensible to cut down on this thickness of base course, in accordance with conditions as you may find them; but one thing must be kept in mind and that is that any macadam surface requires considerable depth of base course, or foundations material to distribute the surface pressure over a good area of subgrade.

Application of Bituminous Material.—To the writer there is always a very intimate relation between depth of penetration course, size of stone used, and the amount of bituminous material applied. We are very cautious to control the amount of bitumen by weight when handling the fine and coarse types of asphaltic concrete. And, although we rely a great deal for stability on the interlocking particles of stone in bituminous macadam, we should have a quantity of bituminous material sufficient to cover the surfaces of the particles. If it is determined by practice and investigation that a certain specified amount of bituminous material will accomplish this for a given depth and grading of stone, we should adhere to this quantity for the conditions determined and not depart from this by way of being careless of the depth of stone. During 1927 and 1928 construction, the writer has had excellent results using approximately 1.75 gal, for the first application and 0.75 gal. for seal coat where the nominal depth of course was 3 in. and the stone trap rock of commerical 2 in. size (passing 2½ in. and retained on 1½ in). These rates conform to good practice and are closely watched by the writer during construction.

In connection with the use of bituminous material, probably the outstanding offender is the one who uses a surplus of material with resultant "fat" spots. The writer has frequently observed men lacking experience in the use of bituminous materials, who naturally believe that a good "dose" of the "black stuff" is good insurance and work accordingly. This getting out of hand should not occur on important

road work as this item is pretty carefully controlled, but you can observe it in small repair work or very small projects where experience is not the guiding hand.

Grading and Application of Keystone. —There is one detail of construction of bituminous macadam which has occurred to the writer to deserve perhaps a little more mention that it usually gets. This is the matter of grading and application of the so-called "keystone" following the first application of bituminous material. Up to a short time ago, at least, there appeared to be two "schools" in New England when it came to this detail of contruction. One prominent state was using the same sized stone for "keystone" and final seal coat topping, this being a trap product passing ⅝ in. and retained on ¼ in. (so-called "pea stone"). The other school used for "keystone" a product passing 1 in. and retained on ⅝ in. and for seal coat "pea stone" size passing ⅝ in. and retained on ¼ in. Both states apparently secure good results, although in the former case the mosaic of the larger road stones is much more clearly defined, while in the case of the use of the ¾ in. stone after penetration followed by the use of the "pea stone" for seal, the mosaic appearance is obscured and the surface is for some time after construction somewhat rougher in texture. The writer has had very satisfactory results with the use of the two sizes of stone in connection with the bituminous applications and it would appear to be more in keeping with a desire to get density and stability by using more graded stone materials. Moreover, there is apt to be dust troubles when the smaller size stone is applied to first applications. Clear stone is much to be preferred even if this product does seem a little "coarse" and has an apparent tendency to break the initial bond of stones in the wearing course.

The writer has found it well worth the trouble and small expense involved to take care to broom the chips about after rolling with a view to filling surface voids uniformly, and after removal of surplus chips to roll lightly again. This rolling seems to give a better appearance to the road surface when finally finished with the seal coat application.

In conclusion, much of the foregoing comment will seem elemental to those who have made a close study of the essentials to good construction of bituminous macadam construction, but the purpose of this article will be served if it will help to impress the less experienced with the importance of watching details in the progress of this type of road construction. The matter contained herein has been discussed without much thought to taking the several points of construction as they are met in the order of work.

Engineers in Public Life

A recent canvas by the American Engineering Council disclosed a number of engineers holding responsible positions in the political life of the nation. The study covers a canvas of governors of all states and members of the senate and house of representatives.

Beside the engineer in the chief executive's chair, President Herbert Hoover, those listed are divided into three classes. First, those who are or were at the time of their election to public office, professional engineers both by training and experience. The second group comprises those who have been engaged in work which is essentially engineering and which requires the engineering mode of thinking and method of approach. The third group is of those who received their basic training and education in engineering—those who received a bachelor of sicence degree in an engineering school, but have subsequently taken up other fields of activity.

Engineer Governors. — The governors who are professional engineers are: Clayton D. Buck, of Delaware; George H. Dern, of Utah; F. C. Emerson, of Wyoming; Morgan F. Larson, of New Jersey, and George A. Parks, of Alaska.

Governor John H. Trumbull of Connecticut has received no engineering degree, but has been engaged in the manufacture of electrical machinery, having been president of the Trumbull Electric & Manufacturing Co., chairman of the board of the Colonial Air Transport Co., director of the Hartford Steam Boiler Inspection Co., and similar enterprises.

Governor Bibbs Graves of Alabama, although a lawyer, received his first degree as a bachelor of civil engineering, University of Alabama.

Governor O. M. Gardner of North Carolina, was a student at the State College of Agriculture and Engineering and received a B. S. degree from the University of North Carolina.

Governor Harry S. Leslie of Indiana received the degree of B. S. from University of Purdue.

Two recent and well-known ex-governors are professional engineers: James G. Scrugham of Nevada and James Hartness of Vermont, past president of American Engineering Council.

From this survey there would seem to be a decidedly increasing tendency of the public to trust men of engineering training with public office. Iu 1920 there were but two governors of states who could be placed in one of the three classes above. In 1910 there were likewise only two.

Engineer Senators.—In the U. S. senate of the 70th congress there were five men with engineering training and experience. These were: Vice-President Charles Dawes, Senator R. B. Howell of Nebraska, Senator H. W. Keyes of New Hampshire, Senator Tasker L. Oddie of Nevada, and Senator Millard E. Tydings of Maryland.

A decided increase in the number of men who have engineering training and experience is shown. In 1920 the senate had but two men who could be placed in these classifications, and in 1910 there were three.

Engineer Congressmen. — The house of representatives in 1910 contained three professional engineers and three members with engineering experience, also three with B. S. degrees. The house of representatives in 1920 contained two men with engineering experience and thirteen who had received B. S. degrees. The house of representatives of the 70th congress, 1929, contained a total of 21 members with engineering training or experience.

The five members of the house of representatives, 70th congress, who may be classed as professional engineers, are: L. W. Douglass of Arizona, H. L. Englebright of California, S. S. Arentz of Nevada, Ernest R. Ackerman of New Jersey, and J. T. Deal of Virginia. The following have had some engineering experience: Paul J. Moore of New Jersey, Wm. L. Carss of Minnesota, John McSweeney of Ohio, Franklin Menges of Pennsylvania, and Louis Monast of Rhode Island. The members who have had training in some engineering institution and in most cases have received B. S. degrees from an engineering college are: R. A. Green of Florida, L. J. Dickinson of Iowa, W. B. Gregory of Kentucky, David Kincheloo of Kentucky, W. P. Martin of Louisiana, W. P. Colo of Maryland, Jess Bushby of Mississippi, F. M. Hale of New Hampshire, A. J. Griffin of New York, George C. Peery of Virginia and F. T. England of West Virginia.

Training City Managers

The report of the Committee on Curricula of the International City Managers' Association, according to the Toledo City Journal, indicates that there are now five universities offering courses designed especially for the training of city managers, namely, Michigan, Syracuse, California, Stanford, and the Agricultural and Mechanical College of Texas. There are several others offering courses which might be considered suitable for the training of city managers, but which have never been organized as such. These include Chicago, Cincinnati, Harvard, Illinois, Kansas, Ohio, North Carolina, Wisconsin, and the National Institute of Public Administration. A number of others such as Northwestern University, Western Reserve and Toledo University, which the committee might well have considered in its report, while giving a great deal of municipal government make no special claim to training city managers.

Water Supply Costs

Unit Costs of Collecting and Distributing Systems

SOME interesting figures indicating the expenditures required for supplying water to large population centers such as the New York region are given in the report "Physical Conditions and Public Service" of the Metropolitan New York region of the Committee on Regional Plan of New York and Its Environs. The report was prepared by Harold M. Lewis, Theodore T. McCrosky and Raymond A. O'Hara of the Engineering Staff, Regional Plan, Hastings H. Hart of the Russell Sage Foundation and Henry C. Wright, Hospital Consultant. The matter following relating to unit water supply costs is taken from advance page proofs of the report.

Collecting Systems.—The Catskill System of the City of New York was constructed between 1907 and 1926, and includes Ashokan, Schoharie, Kensico, Hillview and Silver Lake Reservoirs. Its total cost was about $188,000,000 and it provides 600 million gallons daily. This gives a unit cost of approximately $313,000 per million gallons daily.

The cost of the Ridgewood System on Long Island, which was started in 1850, was, up to 1906, about $16,900,000 including reservoirs.[1] This furnishes 127 million gallons daily and the unit cost amounts to $133,000 per million gallons daily.

The Joint Board authorized by the Massachusetts Legislature to report on the water supply of the Boston Metropolitan District estimated, in 1922, that a new system to supply 202 million gallons daily would cost $59,946,540 or about $300,000 per million gallons daily.

Hazen, Whipple & Fuller, in their report to the Board of Conservation and Development of the State of New Jersey, in 1922,[2] estimated that new supplies would cost from $173,000[3] to $417,000 per million gallons daily. The North Jersey District Water Supply Commission estimated, in 1926, that the unit cost of the 100 million gallons daily of the Wanaque project would be $204,000 and that the complete development of the Chimney Rock project to furnish 750 million gallons daily would be $229,000.[4]

The Board of Water Supply of New York City estimated that proposed new supplies in Putnam, Dutchess, Columbia and Rensselaer Counties, totaling 422 million gallons daily, would cost $575,000 per million gallons daily, while an initial development of 204 million gallons daily from the same sources would have a unit cost of $736,000.[5] The New York City project for developing new sources in the watersheds of the Delaware River and Rondout Creek has been estimated to have a unit cost of $505,000 for a yield of 510 to 540 million gallons daily.[6]

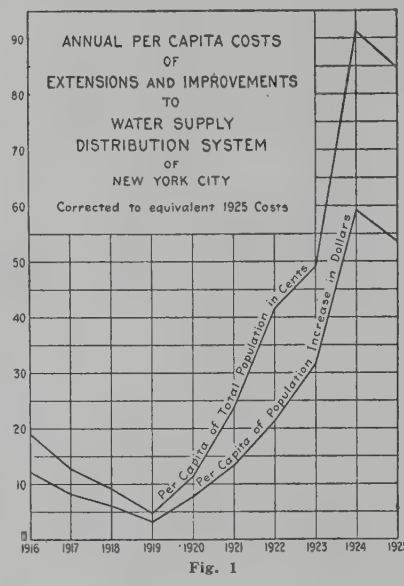


Fig. 1

It is probable that additional supplies for that part of the Region east of the Hudson River will cost from 50 per cent to 100 per cent more per million gallons daily than did the Catskill supply, or $450,000 to $600,000.

It can be assumed that the territory west of the Hudson River can be supplied more economically due to its readier access to sources of supply, or at costs per million gallons daily of approximately $250,000 to $450,000.

The per capita cost of developing a water supply (exclusive of distribution system) now varies from $30 to $60. An average figure would be about $50 per capita.

The consumption per capita in New York City in 1925 was about 140 gal. per day. An average figure for estimating future demands in the Region would be about 150 gal. per capita per day.

Distribution Systems.—The distribution system for the Ridgewood supply in Brooklyn cost, up to 1906, about $13,197,000. By 1926, New York City was spending about $8,000,000 per year on its distribution system. This was high as it included some deferred costs due to lack of funds during the war period. Such expenditures were considerably less than normal for about ten years after the opening of the Catskill System as the main aqueduct, which passes under the city, took the place of many new trunk distribution lines that would otherwise have been necessary. In March, 1927, plans for an auxiliary deep-level aqueduct for Catskill water estimated to cost $67,249,000 were approved by the New York City authorities. This will run from Hillview Reservoir in Yonkers across the Bronx, under the East River, and across Queens and Brooklyn, and will be 17 ft. in diameter for the greater part of its length. It was estimated that it would take about seven years to complete it.

The normal figure for extensions to the distribution system would be in the neighborhood of $4,000,000 per year. The maintenance charges upon the distribution system are approximately $1,250,000 per year. The average annual increase in water supply requirements in New York City from 1915 to 1925 was about 32 million gallons per day.

A factor for use in estimating future costs of extensions and improvements to the distribution system was obtained by taking the Department of Water Supply records for disbursements on the distribution system from 1916 to 1925, correcting these for changes in the cost index and reducing them to costs per capita. The results, shown in Fig. 1, give a curve which may be applied to future population.

The cost per capita, reduced to 1925 money values, has increased steadily from 1919, when it was 5 ct., to 1924, when the figure was about 91 ct., and in 1925 it dropped to 85 ct. The cause of this rise is explained above. As such expenditures are primarily for the use of the additional population, a curve has also been added for per capita expenditure on the basis of the annual population increase. This is seen to have varied from three to $59 and to have been about $53 in 1925.

Training Schools for New York State Municipal Employees.—A comprehensive program for the training of all groups of municipal officials and employees was adopted at a recent meeting of the Advisory Committee of the Conference of Mayors and Other Municipal Officials of the State of New York, according to the City Record, Boston. Ten years will be required for putting into effect the complete schedule, which calls for the establishment of training facilities for health, fire, charities and financial officials, civil service employees, water bureau superintendents, purchasing agents, city and village clerks, park officials and assessors. The conference has plans already under way for the training schools for fire department and charities department employees similar to those now being organized for police training, and the training of health officers is being taken care of by the State Health Department.

[1] Long Island Sources—Report by Board of Water Supply, 1912, Table 20, page 300.

[2] Report on Water Resources of the State and Their Development, January 28, 1922, page 63.

[3] This was based on a complete development of the proposed Long Hill System to provide 750 million gallons daily. The earlier steps in this system would call for much higher unit costs.

[4] 1926 Report, page 87.

[5] Computed from figures given in Report on New Sources of Water Supply, by the Chief Engineer, Board of Water Supply, September 13, 1926, page 6 and appendix of same, page 11.

[6] Computed from figures given in Report No. 36829, Chief Engineer, Board of Estimate and Apportionment, October 6, 1927, page 1.

The Identification and the Control of Algae

How to Identify Various Species and Control Them

By L. B. MANGUN

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CONTROL of algae is, of course, the all-important objective, and the average water works man, usually very practical and very busy too, is primarily interested only in what contributes directly to that end. If, as in the case of one class of microscopic plant life, bacteria, there were some of the algae which caused disease if swallowed by humans, among many others which were harmless, then he would have had the same reason to be concerned about the identification of the harmful ones that he has had for differentiating Bact. coli. And if that were true there would undoubtedly have been some well-defined standards set up for his guidance with respect to them. But, as is doubtless understood by every one, algae in themselves are believed to have no sanitary significance. Rather, their presence in a water supply is usually thought of as objectionable for aesthetic reasons, because they impart color and cloudiness to the water. All forms of algae are obnoxious from the standpoint of appearance, but further than this, most of them cause the water to have a disagreeable taste and odor, and this fact does have an indirect sanitary significance. The public, not knowing the cause of the taste odor and ignorant of its harmlessness, will always imagine the worst, and in an effort to avoid fancied dangers many people will resort to the use of other supplies which may be available, such as wells and springs, which may indeed be unsafe bacteriologically.

Identification of Assistance.—Although identification of algae is not absolutely essential to control, it is nevertheless often of considerable assistance, just as complete knowledge about any process is more desirable than ignorance on the part of the person in charge of it. This information about the algae species with which one is dealing is valuable for record purposes and comparative study. It makes possible an understanding of their genesis, their life history, and perhaps a forecast concerning the probable future course and final results of their development. Incidentally, where the operator has the time and inclination he will find it an exceedingly fascinating study. The simplicity of the most essential laboratory manipulations in the process of identifying at least some of the more common forms is such that almost anyone, regardless of previous training, may do enough to become interested, if one has a little equipment with which to do the work. This need not be extensive, but a good compound microscope is essential. If a microscope is already at hand, the little other necessary apparatus is relatively simple and inexpensive.

Quantitative Estimation of Plankton.—Before taking up a discussion of identification of algae it would be well to give attention to the quantitative estimation of plankton, because it is probably of even more practical importance for control purposes than the determination of the identity of the organisms. By plankton is meant all microscopic, or near microscopic, aquatic life, other than bacteria, and excepting plants which are attached to the shore or basin walls. Many forms of tiny plants and animals suspended in or floating upon the surface of the water are collectively known as plankton. If the operator is to keep an open reservoir situation well in hand it will be of great assistance to him to keep a watch on the number of these plankton organisms present. Whenever he observes a sudden tendency for them to increase it will serve as a warning to him to apply treatment before their multiplication reaches the nuisance stage and be the cause of complaint on the part of consumers. If an initial increase in numbers is checked by treatment at once there will also be less of the objectionable after-effects due to the presence of large numbers of dead organisms in the water.

For the purpose of enumeration, in addition to the microscope, a counting cell, and ocular and stage micrometers are necessary. A Sedgwick-Rafter filter is sometimes a valuable assistance, though not often necessary for control purposes in settling basins and distribution reservoirs. This apparatus may be purchased from any of the laboratory supply houses. The counting cell is filled by means of a pipette with water from the sample as taken, or in case the organisms are few, with a concentrated sample from the Sedgwick-Rafter filter. After counting the organisms in a dozen or more squares and determining the average, the appropriate factors are used to find the number per cubic centimeter.

Standard Units.—It is sometimes more meaningful to state the quantity of the organisms in "standard units," which is a measurement in terms of volume rather than a mere count of numbers, because a large number of small organisms, such as the Protococcus forms, would affect the appearance of the water far less than a much smaller number of a large species, like Volvox. The area of the smallest square shown by the ocular micrometer is 400 square microns, which is equal to one standard unit. One Volvox per cubic centimeter would be equivalent to about 490 standard units, while 25,000 of some of the Protococcus species would be required to give the same number of standard units. The estimation in terms of standard units is preferable when the name of the organism is unknown, but if the organism is identified and its name given, then number alone has a more definite meaning. However, if there is a mixture of organisms the use of the standard unit is most desirable, and it is obligatory in making any definite quantitative statement concerning debris—broken-down amorphous masses from the disintegrated bodies of dead organisms.

Before the observer will have finished with the counting, if he is endowed with only the average amount of curiosity which characterizes the human species, he will have become interested in knowing something more about the tiny creatures with which he is dealing. He will want to see them better, and, as the low power of the microscope has probably been used for the counting, he will not be long in reaching for the 4 m. m. objective to get a more enlarged view. Next the question involuntarily comes to him, "What is it?" He may not be a botanist or a zoologist, but he feels much the same as he does when visiting the zoo or the circus, where he wants to see the names of the strange animals placarded on the cages, and he experiences a sense of irritation and dissatisfaction if the names are not there. He also would like to know from what country they come and he would be interested in any bits of information about their habits and manner of living. Now, there is probably as much incentive to satisfy that natural curiosity concerning the names of the algae as there is because it will enable him to say whether or not the organism will impart a taste to the water, what that taste will be like, and how much of a dose of blue vitriol will be required to kill it. This brings us to the subject of identification.

Identification of Algae.—If the water works operator has never studied botany or zoology at all, or extensively enough to have obtained some knowledge about the lowest forms of life, it would be very desirable for him to get an elementary treatise on biology from the

library. In the event that he has had an unpleasant and perhaps unsuccessful encounter with algae in his water supply, and especially after he has seen some of them under the microscope, he will find that, having made that sort of an approach to the subject, the book will be of the most absorbing interest to him. He will be amazed at the wonders he finds in this, to him, new world which he has discovered.

It is not intended to intimate, however that our amateur student of biology must master the details of structure and the intricacies of classification—species, genera, orders, etc.—before he can hope to identify any of the organisms found in plankton. He should procure a book containing descriptions and colored plates of the species most commonly met, such as Whipple's Microscopy of Drinking Water or the more complete Ward and Whipple's Fresh-water Biology, both published by John Wiley & Sons, New York. Though he may not be able to use the keys contained in these books at all systematically, even the most haphazard search in them will often reveal unmistakably the identity of the species, or at least the genus, he has met, unless it should perchance be an uncommon one, which rarely happens. As a matter of actual fact it is usually the genera and not the species one hears about. For example, the presence of Anabaena is reported in a certain reservoir. New, there are several kinds of Anabaena, but for practical purposes, the difference between them is not worth considering. The identical species one has under the microscope may not be shown in either of the books referred to above, but its resemblance to the one pictured will be such that one will know it to be a species of Anabaena. He will find, after locating it in this manner, that it belongs to the blue-greens, that it will impart a grassy or moldy odor to the water, and that a concentration of 0.1 p. p. m. of blue vitriol will be required to destroy it. Thus, while there are more than 1200 known species of blue-green algae, the number of genera are much smaller, and the most common among them are illustrated in these books. Whipple's book contains excellent colored plates showing nineteen species of the Cyanophyceae, or blue-greens, forty-eight of the Chlorophyceae, or greens, and fifty-one of the Diatoms. Then there are representatives of the microscopic aquatic animals, principally Protozoa. The Protozoa are the most important class of the non-algae plankton, of which forty-three species are illustrated.

What Algae Are.—It would perhaps be desirable for the orientation of beginners to explain briefly what algae are, and, since the authors referred to do not do so, to say a few words concerning the place they occupy in the world of living things. The term Algae is often used very loosely, sometimes almost synonymously with the word plankton, which includes both plants and animals. Algae are plants, and constitute one of the three groups of plants called Thallophytes, the name given to those having no root, true stem, leaves, flowers, or seeds. The other two Thallophyte groups are bacteria and fungi, which differ from algae in that they have no chlorophyll. The algae are characterized by the presence of chlorophyll, but the green color of chlorophyll is masked in many of them by yellow, brown, red, or blue coloring substances. The fresh-water algae are divided into three classes, the diatoms, which are yellowish-brown, the blue-greens, and the greens. The last group are algae in the strictest sense of the term, though botanically algae include the diatoms and the blue-greens also. The brown and red orders of the algae are mostly marine, and are therefore not encountered in our water supplies. Diatoms are one-celled, usually free-swimming, and are the most numerous order of the algae, more than 12,000 species being known. The greens and blue-greens are either simple unicellular or filamentous, the latter free-floating or attached. About 1,200 species of the blue-greens and 5,000 greens have been identified. In addition to the algae the plankton plant-life includes a few of the non-chlorophyll Thallophytes, yeasts and molds, which belong to the fungi.

The representatives of the animal kingdom found among the micro-organisms inhabiting fresh water are the Protozoa, which are unicellular organisms, the lowest form of animal life. Then there are other minute animals which are multicellular, the Rotifera, or wheel-animalcules, the Crustacea, or water insects, and the Bryozoa and Sponges, both of which are animal groups, though they are fixed and plant-like in appearance.

This animal life feeds upon the vegetable portion of the plankton, Hence. if the algae are not allowed to flourish these organisms are held in check through deprivation of their food supply. That is fortunate, because the algae are more susceptible of the poisoning action of the treating agencies than are most of the animal groups.

Attempts have been made to control algae in uncovered reservoirs by stocking them with fish which feed upon the algae, upon the assumption that fish are a less objectionable form of life in a water supply than algae. This plan has difficulties. If the basin is overstocked there will not be sufficient food and some of the fish may die. Dead fish are even less desirable in a finished water than live ones. On the other hand, if the fish are too few they will not consume all of the algae, especially at times when it is growing most rapidly, and it is very difficult under these conditions to treat the water chemically to destroy the excess algae without killing the fish wholesale.

Methods of Control.—The most common method of control has been by the application of algaecides to the water. Until quite recently blue vitriol was used almost exclusively. It gave very satisfactory results in large impounding reservoirs, and it is still the favorite treatment in them. Under those conditions dosages low enough to be harmless to fish life are usually effective. But blue vitriol never gave correspondingly satisfactory results in settling basins and storage reservoirs, and during the past two or three years chlorine has been rapidly displacing it. The continuous change of water in these reservoirs makes frequent treatment necessary. Where there is a constant flow of water, as in settling basins, continuous treatment of the influent is desirable, and that should probably be considered a misuse of blue vitriol because of the possible cumulative effect of copper. But the generally turbid character of the surface supplies of Kansas protects the water as received from carrying excessive plankton growths, such as would give trouble from tastes or clogging of filters. Algae, in common with all chlorophyll producing plants, require sunlight, therefore they do not multiply in water not clear enough to allow the sun's rays to penetrate beneath the surface. In the event that there is sufficient retention of the settled water in the finishing basins, there would be an increase of algae in them proportional to the clarity of the water and the length of the period. But retention is probably not of sufficient duration in many cases to give serious trouble, so that, while prechlorination, i. e., chlorination of the raw water, is being employed in some instances and has given admirable results with respect to its algaecidal action, these have been incidental to the primary objective of this chlorine treatment, which has been to reduce the bacterial load upon the filters. Where clear water is constantly moving through an open basin, soon to be delivered to the filters and thence into the underground distribution system, there is slight opportunity for plankton growth. Therefore, the free-floating forms do not become abundant. But the filamentous types which cling to the weirs and walls do grow very well under those conditions, and the growth is most luxuriant where the movement of the water is most rapid. Prechlorination has proved to be decidedly effective in keeping down these clinging forms, thereby making possible the maintenance of clean basin walls without the necessity of frequent removal by mechanical means, such as scraping, or the lowering of the water and spraying the walls with blue vitriol solution to kill them.

Prechlorination.—A maximum chlorine dosage of about 1 p. p. m. in summer and 0.25 p. p. m. in winter has been sufficient to produce the above results at the Kansas City purification plant. Chlorine has been used as an algaecide

for such a short time that probably no one has yet determined with exactness the minimum dosages required to destroy the different species. Whipple's work, published fifteen years ago, gives data of this kind with respect to blue vitriol only which were the results of Moore and Kellerman's experiments a decade earlier. At Kansas City the chlorine dosage in the settling basins has been regulated with respect to its germicidal action only, but chlorine has been used for two years as an algaecide in the open storage reservoir which is a part of the City's distribution system.

A further result of prechlorination has been the elimination of Bryozoa from the filters, those strange animals so plant-like in appearance, related to the coral of the sea. These Byrozoa would formerly attain a length of several inches in the Kansas City filters, where they presented a matted appearance on the walls and a shaggy, manelike effect as they hung downward from the troughs when the filter was drained. They could be washed loose by a stream of water from a garden hose and they were periodically removed in that way. But they disappeared soon after chlorination was begun and that operation is no longer necessary.

The conditions of algae growth and control in uncovered storage reservoirs differ radically from those obtaining in settling basins. There is no continuous flow of water through the typical storage reservoir, but rather, an alternate inflow and outflow, oftentimes of such relatively small proportions as to cause an approach to a condition of stagnation. Here is such abundant opportunity for cumulative growth of plankton life that, given the extremely favorable conditions of light and temperature which are often ideally provided during the summer months, frequently the rapidity of their multiplication is best described by the word explosive. Within a day's time a relatively clear body of water may take on a very clouded appearance, due to the sudden production of countless millions of algae, usually all of one species. In the spring these will probably be diatoms, in summer, the greens, in late summer, the blue-greens, and in the fall, diatoms again, but none of these classes are strickly confined to those seasonal divisions.

Recent experiments have demonstrated the superiority of chlorine over blue vitriol for algae control in storage reservoirs, but whatever agent is used it is obvious that the method of application must be entirely different from that in settling basins. In the former it is necessary to treat the entire contents of the reservoir at one time. This may be done from a boat or, if the arrangement of the reservoir is such that the incoming water can be caused to mix thoroughly with the algae-laden contents of the reservoir, the chemical may be more conveniently applied to the influent, at a time when the direction of flow is inward, which is usually at night. As in the case of settling basins, a dosage of 1 p. p. m. has been effective in the Argentine reservoir at Kansas City, during the warm portion of the year. No treatment at all is usually necessary from October to May. In storage reservoirs the treatment is best applied intermittently, when required, and not continuously, and it is used only as often as experience with local conditions and the rate of algae growth indicate to be necessary.

The control may generally be considered as satisfactory if the number of organisms is kept down to one or two hundred per cubic centimeter. Trouble from most species may be expected if the number exceeds 1,000, and serious trouble if over 10,000. With respect to production of tastes and odors, however, quite as much depends upon the species as upon numbers, since the quality and intensity of the tastes produced varies among them, and some affect only the appearance of the water. Thirteen thousand Synedra per cubic centimeter in the Argentine reservoir in one instance elicited no complaint from consumers on account of taste.

Acknowledgment.—The foregoing is an abstract of a paper presented at the recent meeting of the Kansas Water Works Association.

Destroying Slums by Excess Condemnation.—The Regional Plan of New York and Its Environs, according to the City Record, Boston, calls attention to the fact that under the New York statutes, although not explicitly stated, excess condemnation may nevertheless be used as an indirect means of improving housing and destroying slum areas. A tract consisting of several streets and the land between them can be chosen; the land between the streets condemned; the streets closed, widened or changed in location; and the central portion of the land turned into a public park or utilized for some other public purposes. Excess land around the boundaries, not needed by the public, can be sold under proper restrictions aimed to insure an appropriate building development. By proper management, this can be done at a good profit. The public use must, however, be the primary purpose of the proceedings.

How Philadelphia Helps Relieve Traffic Congestion.—The city of Philadelphia has a plan whereby parking fields are maintained, outside the downtown districts, where motorists may park their cars for 25 cents, which also includes carfare on the Philadelphia Rapid Transit lines to and from the downtown districts. The system gives considerable relief for traffic congestion.

Street Cleaning at Toronto, Ont.

Methods and Costs of Work in 1928

THE general duties performed by the Department of Street Cleaning of Toronto, Ont., embodies the cleaning of public streets, lanes and thoroughfares, the collection and disposal of ashes and household waste material, the cleaning of catchbasins, the oiling of unimproved roadways and the removal of snow from the downtown section and main car lines. The following information relating to this street cleaning and road oiling is taken from the 1928 report of George W. Dies, Street Commissioner.

Patrol System.—The patrol system is used in the downtown business area and main business thoroughfares; that is, each patrolman has a defined area to patrol, which may be covered from one to eight times a day. According to its requirements, each patrolman is provided with a paper picking bag, push cart, broom, scraper and shovel. He covers his beat on the first round each morning with the paper bag, and removes all loose paper which may be on the boulevards, walks or roadway. He then commences his rounds, removing all street dirt which is deposited in the pushcart. As the tubs are filled, they are left at designated points, to be later picked up by a truck.

The remaining sections are under the squad system, that is, the men working in pairs, one on each side of the roadway, followed by a pick-up vehicle. This system is carried out in residential and outlying sections.

The various streets receive a cleaning once or twice weekly, according to their requirements and the funds available.

The congestion of motor traffic increases the hazard of the patrolman's work, as well as retarding the efficiency of the men. Parked motor cars and vehicles prevent the proper cleaning of the channels and the removal of litter.

The enormous amount of building which has been projected during the past year has also added its quota to the difficulties which attend this important service. These are, however, contingent perplexities which must of necessity be met by all municipal administrations and can to a great measure be coped with by adjustment of hours of work.

Each patrolman maintains on an average three miles of street, covering approximately 40,000 sq. yd., an area far too large to be properly covered by one patrolman. Street dirt should be removed as near as possible to the time of its origin, in order that vehicular traffic may not grind it into a fine dust

to be scattered by the prevailing winds to the general discomfort and annoyance of the public.

There is perhaps nothing so offensive to pedestrians than to be met by a dust-laden gust of wind. This condition is impossible to control at certain times during the fall of the year, when there are high winds and street flushing is impossible, due to the dangerous and slippery condition that would be created.

Unit Cost of Hand-broom Sweeping of Improved Roadways for 1928

Total cost (foremen, labor, cartage, supplies)	$277,866.00
Area of improved street mileage (square yards)	7,606,991
Cost of maintenance per 1,000 sq. yd. per season	$36.53
Amount of sweepings collected (cu. yd.)	105,602
Cost per cubic yard (sweeping, collecting and removing)	$2.63
Cubic yards removed per 1,000 sq. yd. per season	13.9
Number of patrolman at $28.80 per week	190
Average area maintained per patrolman (square yards)	40.037
Average number of times swept per season	90
Cost of sweeping per 1,000 sq. yd. (sweeping, collecting and removing)	$0.406

Catch Basin Cleaning.—Catch basin cleaning is carried out systematically in each Division. The general work is usually commenced immediately after the spring cleaning of the streets. During the winter season they are given such attention as may be required, in order to keep them free from ice and obstructions.

The supervision of the work is under the direction of the district foremen. In certain outlying sections, the culvert cleaning squad, which consists of two culvert men followed by a pick-up vehicle, may operate through two foremen's districts. In the downtown and business sections, the culvert man is provided with a vehicle in order that the "cleanings" may be removed immediately from the channel.

All catch-basins are thoroughly cleaned in the spring, which is usually sufficient until the fall. On main thoroughfares, subways and troublesome locations, constant attention is given throughout the season.

Many householders are of the opinion that the gutters are provided on roadways for the convenience of placing grass cuttings and lawn rakings in. This practice, in the event of heavy rain, is the most common source for blocked gratings and culverts, the material being conveyed to the gratings by the flow of water, often completely blocking the openings.

The distribution of notice cards directing householders' attention to the fact that it is a contravention of the by-law to place grass cuttings or lawn rakings loosely upon the streets, has resulted in a marked improvement in this regard. It is, however, a problem which requires the constant attention of the inspectors throughout the summer months.

Summary of Catch Basins Cleaning, 1928

Expenditure (wages, cartage and supplies)	$18,353.09
Number of cubic yards removed	12,260
Number of basins cleaned	50,621
Cost per cubic yard (cleaning and removing)	$1.49
Cost per basin per season	0.36

Flushing.—The department had in operation last season, two electric and one gasoline flusher. The electric flushers are operated under air pressure, while the gasoline flusher is operated by a centrifugal pump.

The electric flushers are confined to night flushing in the downtown section. The streets receive a flushing each alternate night. The trucks are operated together, as by this method the best results are obtained, owing to the fact that it takes a few minutes for the dirt to become saturated, so that the second flusher may readily wash it into the gutter. On this account, a light rain just before or during flushing, aids considerably in obtaining real cleanliness, and is taken advantage of by operating the flushers as single units.

The gasoline flusher was engaged upon special flushing, due to the extensive excavation work and building operations carried out during the past summer. The contractors were required to remove any material that fell from trucks when leaving the excavation or on the route to the disposal point. Owing to the extent of several of these excavations and the continuous travel of the dump trucks hauling the earth over the same route, it was necessary to keep this flusher operating on these streets.

Street Flushing, 1919-1928

Year	Street Mileage Flushed	Quantity of Area Flushed (1,000 Sq. Yd.)	Quantity of Water Used (1,000 Gal.)	Cost per Mile	Cost per 1,000 Sq. Yd.
1919	1,670	33,827	8,546	$3.44	$0.1696
1920	3,169	61,400	15,435	3.05	0.1576
1921	3,834	77,869	20,591	3.29	0.1613
1922	7,156	161,416	35,100	3.03	0.1345
1923	3,865	90,326	22,267	3.56	0.1620
1924	3,332	83,358	18,355	3.54	0.1420
1925	1,702	39,318	10,830	3.65	0.1580
1926	1,615	37,680	8,950	3.25	0.1390
1927	1,294	30,405	7,173	3.24	0.1380
1928	2,002	46,110	9,563	3.18	0.1380

Road Oiling.—During the past year 750 applications of oil were made on 304 streets and 23 lanes. Several of these received as many as six applications, while others received only one. This was due to the nature of the roadway and amount of traffic passing over it. A sandy or soft road bed will soon absorb the oil and the constant disturbance by the vehicular traffic turns up the fine dust, making several applications necessary, while on a hard surfaced or macadam roadway, one application will last several months.

The oil is applied by motor truck, which is equipped with a square steel tank with a capacity of 1,170 gal. It is applied cold by means of a 2½-in. perforated horizontal pipe, 8 in. from the ground, and at the rear of the tank. The amount of oil used is based upon the condition of the roadway, while the flow of oil is controlled by a valve, operated by a conductor on the rear platform.

The oil is purchased in tank-car loads, which have a capacity of 5,000 to 8,000 gal. These tank cars are unloaded into storage tanks by a centrifugal pump, operated by a gasoline engine, which is capable of unloading a car of oil in two hours.

There are four oil storage tanks, with a total capacity of 120,000 gal. From these tanks the motor truck is loaded by gravity, utilizing the tank nearest the district in which it is working. The first load each morning is taken from the storage tank at the Don destructor, which adjoins the garage where the truck is housed.

The necessity of an oil storage tank in north Toronto is clearly demonstrated by the fact that 70 per cent of the amount of oil used, or 183,557 gal., was applied on north Toronto streets during last season.

Four years ago, only 39 per cent of the oil purchased was applied in this district, covering 64 streets. This number has now increased to 138 streets requiring oiling. The nearest storage tank is located at the Don Destructor, which on the average necessitates a 5-mile haul. This overhaul was in a measure overcome last season by spotting tank cars of oil on the Merton Street siding, from which point the oil truck was filled by the pumping outfit. The oil truck was able to distribute a tank car of oil a day in this manner, it also eliminated a long uphill haul and covered 25 per cent more actual work. This practice was not without difficulties, and additional expense. In the event of rain, the work was discontinued, and a day or so must elapse in order that the roadway may dry out to a certain extent. This incurred demurrage charges as well as blocking the siding. There also was the expense of two men attached to the pumping outfit, while unloading the tank car. It is therefore obvious that a storage tank in this vicinity would effect a great saving, as well as increase the efficiency of the truck.

Road Oiling 1916-1928

Year	Mileage	Area Oiled (1,000 Sq. Yd.)	Gals. Used (1,000 Gal.)	Cost per Mile	Cost per 1,000 Sq. Yd.
1916	181.6	2,863	280	$125.39	$7.59
1917	180.9	2,761	244	149.28	9.78
1918	108.2	1,743	172	203.84	12.65
1919	228.	2,943	354	120.66	9.34
1920	201.6	3,353	253	232.13	19.49
1921	173.8	2,150	253	130.27	10.54
1922	244.2	3,147	361	149.28	10.11
1923	188.7	2,342	338	170.20	13.82
1924	164.	1,886	295	170.34	14.84
1925	142.6	1,606	264	178.32	15.83
1926	136.9	1,613	244	171.31	14.65
1927	135.7	1,527	267	178.39	15.83
1928	139.1	1,578	294	153.29	13.51

A Common But Fallacious Doctrine

By HALBERT P. GILLETTE

"YOU can not, in reality, prove anything by mathematics," according to Dr. Charles Lane Poor, professor of celestial mechanics at Columbia University, who has been combatting the Einstein theory of relativity for ten years. Startlingly novel as Prof. Poor's statement may sound to some people, it is quite an ancient doctrine, and none the less false because of its antiquity and the high standing of many of its proponents.

The doctrine amounts to this: Given two premises from which a logical inference is drawn, and it follows that the inference not only contains no new truth but that the drawing of the inference does not serve to establish the truth of either of the premises.

For example:

(1) All gold is malleable.
(2) This specimen is gold.
(3) Hence this specimen is malleable.

If the major and minor (2) premises are true, then the deduced conclusion (3) is necessarily true, but it is said to contain no new truth and that it does not establish the truth of either of the premises, Mill's Logic discusses this doctrine at great length, and he concludes that it is sound; but he fails to see that there is more to this matter than the mere mechanical combination of two premises to produce conclusion.

Using algebraic symbols we may write:

(1) x=a.
(2) a=b.
(3) Hence x=b.

And it is evident that the deduced equation (3) does not prove the truth of either (1) or (2), unless (and here lies the point) we put (3) to some test to determine whether it is a true equation. As a matter of fact Einstein did put his deduced equations to just such a test when he deduced the revolution of Mercury's perihelion and showed it to be in accord with actual measurements. His deduced formulas were again put to the test when he predicted the amount that a ray of light would be deflected by the sun, and the prediction was triumphantly verified.

So while it sounds quite plausible to say that you never get out of equations more than you originally put into them, it is really metaphysical sophistry; for what you truly get out of a deduced physical formula is a mathematical relation that you proceed to test by an appeal to facts. If it agrees (within the experimental or observational error) with the facts, the probability of the truth of the formula may be so great as to amount to certainty. And the greater the number of such agreements the greater the probability of the truth of the deduced formula if applied within the quantitative range that the original premises covered. Moreover, this probability increases not merely in proportion to the number of such cases, but in proportion to the product of their probability ratios. Thus if the probability of truth is 10 to 1 in a given case, and 100 to 1 in another case, and 50 to 1 in a third case, to each of which the formula is successfully applied, then the entire probability in its favor is $10\times100\times50=50{,}000$ to 1. Now it frequently happens that the probability ratios are much greater than those above given for illustration, so that practical certainty of the truth of a formula may often be attained by a single test of it, and a few such tests may raise its probability of its being true "a billion to one shot" or higher.

Among most scientists there is a curious lack of knowledge of the use of the laws of probability in testing the truth of theories. Were it otherwise, so many theories would not have remained unaccepted for decades, generations and even centuries. Couple this ignorance of the use of the laws of probabilities with a false doctrine such as Prof. Poor believes, and you begin to understand why the discoveries of so many scientists have met the same reception that Einstein's great discovery met for 15 years, and even now meets from so distinguished a person as Prof. Poor.

Lest it be supposed that the brief quotation at the head of this article does not fully represent Prof. Poor's position, the entire paragraph from which it was taken (as it appeared in the New York Herald-Tribune) will be given:

"Mathematical processes merely constitute a sort of specialized shorthand; they furnish simplified methods for carrying on elaborate and complicated arguments from assumed or stated premises. A conclusion is derived from certain definite premises, and such conclusion must inevitably involve and depend upon such premises. There is a mathematical law of conservation of knowledge, and you can never get out of any mathematical equations or formulas anything more than you put into them in the first place. You cannot, in reality, prove anything by mathematics."

I have indicated that this doctrine is false in that it fails to include what inevitably occurs in all rational research, namely, a testing of a deduced inference from an hypothesis (or premise) by an appeal to facts. And we have seen that Einstein put his theory to just such tests and that the measured results have agreed with his deduced results. All of which Prof. Poor ignores. Now let us consider a different sort of sophism in this doctrine that "you can never get out of formulas more than you put into them in the first place."

We venture to say that few students of geometry would ever embrace such a doctrine were they to follow the dictates of their own common sense. Take, for example, the deduced formula relating to the sides of a right-angled triangle, namely, that the square on the hypothenuse equals the sum of the squares on the other two sides. The deduction of this theorem might be called the greater "pons asinorum," because no geometrical ass can cross this bridge.

This theorem or formula is deduced by a line of mathematical reasoning that runs straight back to a few definitions and axioms; so apparently all that was put into the deduction was those few definitions and axioms. According to the doctrine under consideration, it was all hidden there when you read the first few and simple pages of your geometry.

If all that is in the "pons asinorum" is in those initial pages of geometry, why doesn't it disclose itself after a little inspection? Why must students struggle for weeks to get to a point where they can even understand what some Greek geometrician discovered more than 20 centuries ago?

When the average young man finds it none too easy to understand some of the pages of geometry, and still harder to remember them, to say nothing of originating such deductions himself, such a young man is not likely to swallow this doctrine without gulping rather hard.

It seems to me that the doctrine that all of geometry lies concealed in or embraced by the axioms and definitions is indefensible. The axioms lay down principles by which a thinking man may discover the properties of geometrical figures. Those properties were just as much concealed from view before the day of Euclid and his immediate predecessors in geometrical research as most of the properties of atoms and molecules were concealed from chemists before Dalton made that initial grand discovery that atoms unite in mathematical proportions as to weight.

It happens that anyone equipped with a pencil and paper, and a few drafting instruments, has at his disposal a geometrical research laboratory. True it is that few are taught to regard it as such a laboratory, and more is the pity; but by Euclid and by many another man of originality, this sort of paper and pencil laboratory was used to discover geometric properties of Nature. I say Nature, for I disagree entirely with those who think that men invented the triangle, the rectangle, the circle, the

ellipse, and all the other elementary geometrical forms. They existed in crystals, in the stems of plants and bones of animals, in the shapes of the sun and moon, in the paths of falling bodies, and in numberless other visible, natural things. But not till man began to study these natural forms did he begin to learn much about their properties. He is still learning, and perhaps never may cease learning, new geometrical properties. To say that these properties have always existed in Nature is true; but to say that they have always existed in the few simple premises (the axioms and definitions) of geometry is utterly false, if words are used to mean what common sense and custom has long prescribed that their meaning shall be.

What is true of geometry is true of all mathematics, in so far as the doctrine under discussion is concerned. Man often gets out of mathematics vastly more than he puts into his initial equations. Even where this seems not to be the case, careful analysis discloses that there has been an illusion. Take, for example, what Einstein put into his deduction that was not in any previous deduction, namely, his principle of relativity in its most general form. The rest of his premises consisted of established facts of physics and of mathematics. From these premises he deduced certain formulas. If results derived by their application to given cases agreed with the facts, such agreement indicated the probable truth of his principle of relativity; which truth, as above stated, was thus established. But this was not the sole test of its truth, for if he could deduce by aid of his principle of relativity a single formula that had been previously deduced from any established theory, then the probability of the truth of the principle of relativity became so great as to amount to practical certainty. He not only deduced one such formula, but many; the first two thus deduced being the formulas for relative length and relative time, previously deduced by Lorentz, who used established electric theories.

What Einstein put into his deductions was more than had previously existed in any similar deductions. Yet at first it seems as if he took out no more than he put in; but what he put in was a guess (even a wild guess) and what he took out was a certainty. The guess (his principle of relativity) became a certainty as a result of a mathematical deduction whose results were in accord not only with several established formulas but with two independent quantitive relations, one of which was already known but unexplained (Mercury's perihelion movement), the other of which was so novel as to be revolutionary in its significance (the gravitative bending of rays of light). If ever in all history a man took out of mathematics more than the mathematics itself contained, this is such an instance. Of course the very same sorts of amazing discoveries have been made by the aid of mathematics many times. Newton's discovery of the law of gravitation was precisely the same sort as Einstein's discovery that all energy gravitates. And in just the same way that Einstein's discovery has been belittled, so was Newton's.

Curiously enough German astronomers long argued that Newton had discovered nothing new, and that all he had found was another way of showing that Kepler's laws of orbital motion were correct. (See Herschel's Essays and Whewell's Philosophy of Discovery.) Apparently those German astronomers held very much the same doctrine as Prof. Poor holds, namely, that you can't get out of mathematics more than you put into it. But I doubt not that Prof. Poor would be among the last to agree with those German astronomers of two and a half centuries ago that Newton had discovered nothing that was not already known to Kepler; for even in the alleged cold world of science, much depends upon national and racial prejudices, to say nothing of the egotisms that make many of us loath to admit that we did not discover a thing that seems so obvious when once discovered.

The part that mathematics plays in research is that of an engine or tool, by the aid of which quantitative relations are deduced. Relations thus derived are put to the test by comparing them with facts, and if agreement is found a physical discovery is said to have been made.

The engine-like nature of mathematics is well seen in the planimeter, that truly remarkable integrating machine by means of which plotted areas may be measured. An irregular closed figure of unknown area lies before you, and a planimeter is in your hand. Does the planimeter contain that area in its mechanical head? Is the unknown area somehow concealed in this machine? The question sounds ridiculous, yet it is not a whit more so than the doctrine under consideration. Just as an unknown area does not lie concealed in a planimeter, so an unknown geometrical relation does not exist in the axioms and theorems by the aid of which that unknown relation can be discovered. Whether a formula is applied by the aid of a pencil and paper or by the aid of a machine, like the planimeter, the formula does not contain the desired answer to a question, but is merely a tool that, under certain conditions, may be used to secure the answer.

It is frequently contended that logic need not be taught as a distinct science, but that all its precepts and methods are readily acquirable during the study of other sciences. And mathematics is itself held up as an excellent illustration of a science that teaches logic. But when professed and skillful mathematicians have no better conception of its fundamental nature as a tool than to believe that the tool can contain the answer sought, and that nothing can, in reality, be proved by mathematics, it would seem needless to argue that there is crying need of the teaching of research logic as such, and not merely as an incidental part of other sciences.

John Fritz Medal Presented to Herbert Hoover

The John Fritz Gold Medal for 1929 was presented to Herbert Hoover at the Executive Mansion, Washington, Thursday, April 25, at a luncheon given by Mr. Hoover to present and past members of the Board of Awards, preceding medalists, and presidents and secretaries of the American Societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers.

This medal is the highest honor bestowed by these four national engineering societies, having a membership of 60,000. It is awarded not oftener than annually for "notable scientific or industrial achievement, without restriction on account of nationality or sex." In accordance with custom, the award to Mr. Hoover was made tentatively and without announcement in October, 1927, and was formally confirmed and announced one year later.

At the presentation on the 25th, Dean Dexter S. Kimball, College of Engineering, Cornell University, chairman of the present Board of Award, presided and gave a brief history of the medal. He is a past-president of the American Society of Mechanical Engineers.

Dr. M. I. Pupin, a past-president of the American Institute of Electrical Engineers, and a member of the Board of Award, spoke briefly of the human elements of Mr. Hoover's lifework.

Dr. John R. Freeman, past-president of the American Society of Civil Engineers and the American Society of Mechanical Engineers, and a former member of the Board of Award, spoke of Mr. Hoover's work as an engineer.

Mr. J. V. W. Reynders, past president of the American Institute of Mining and Metallurgical Engineers, and chairman of the board which made the award to Mr. Hoover, presented the medal and quoted from the certificate which accompanied the medal the citation "To Herbert Hoover, Engineer, Scholar, Organizer of Relief to War-Stricken Peoples, Public Servant."

The ceremonies ended with a statement by Mr. Hoover.

Among the men to whom the medal has been awarded in preceding years are J. J. Carty, Elmer A. Sperry, Edward Dean Adams, John F. Stevens, Ambrose Swasey, Guglielmon Marconi (Italy), Eugene Schneider (France), Sir Robert A. Hadfield (England), Orville Wright, George W. Goethals, J. Waldo Smith, Elihu Thomson, Thomas A. Edison, Alexander Graham Bell.

The Overloading of Sanitary Sewers

Experiences in a New Jersey Town

By ALEXANDER BLAIR
Civil Engineer, Westfield, N. J.

THE cause of overloading of sewers has long been a subject of importance. In 1903 the American Society for Municipal Improvements had a discussion upon flooding, and at that time they attributed quite a large part of it to infiltration. In 1913 the American Society of Civil Engineers discussed the subject. At that time, it was shown that contributory flooding was due to infiltration. It was stated then (and Metcalf & Eddy have since confirmed the figures) that infiltration flow in sewer pipe of 30,000 gal. per mile is a maximum flow—a very heavy flow. Since that time a number of things have been tried to reduce flooding, but in order to minimize the flow the unknown sources contributing must be traced.

Leakage may be found through the walls of manholes or through the perforated slots in the tops of manholes or from pipe lines running through water courses, etc., but after finding and eliminating the sources mentioned, very heavy flooding may still be found. I have had experience with this in two towns, Summit and Westfield, N. J. In Summit about 5 years ago it was found that at certain seasons there was heavy flooding in the system. The entire sewers were gone over and every contributing cause found was remedied, but the flooding still continued.

Infiltration Not Main Cause.—At a later date in Westfield the same condition was found to exist. Only cast iron pipe with lead joints had been used for house connections since 1913, in order to reduce infiltration as well as for other reasons. Everything had been constructed absolutely tightly. All of the sewer laterals and mains since 1913 were laid with the best flexible joints known, and under rigid inspection. Strangely enough flood measurements by the writer in 1924 compared with flood flows recorded after investigation by Hazen & Whipple in Westfield in 1913 showed relatively the same high rate of flow as in 1913, the increase in normal and in flood flows being in almost exact proportion to the growth of the town. This proportion was maintained whether compared in terms of population per mile of sewer, or per house connection made, and since the construction work of the past ten years ensured tightly joined mains and connections it indicated that infiltration was not the cause of the major part of this trouble. Using the infiltration figures quoted, and they are heavy, (30,000 gal. per mile) would only account for 20 to 30 per cent of the maximum flood flows in storm periods, and the normal sewage flow would be only about 10 to 20 per cent of the maximum flood flows. Naturally, the question arose, where is the balance of 50 per cent to 70 per cent coming from?

Survey of Leader Connections.—A survey was made of leader connections, which showed that there were some old houses having leaders taking the roof drainage connected to the sewers; of course, there were a number of pipes running below the surface and in some cases it was hard to tell if those also were connected, but, assuming that they were all connected, that would only account for a very small percentage of the flow. From what source then could this excess come? It was suspected that a number of the builders were misusing the sewers as a drainage system. This was against the ordinance and I think it is so in most towns—but the builders thought that it was legitimate to make use of some existing means of drainage while constructing their houses and in many cases continued it after completion.

Misuse of Sewers by Builders.—In 1924 one violation was found in making the customary test on a sewer lateral just completed, where instead of making the usual internal hydraulic test to see what loss of water occurred when the pipe was plugged at the outlet, the inspector blocked up the outlet as usual, but left the sewer tight and dry, since there was a ground water level at that season well above the level of the sewer, by which an external test might be made. The inspector on returning was very much surprised to find the pipe filled with muddy water and traced it back to two building excavations. The matter went before the council who considered modifying the ordinance so that in future no sewer connection could be made until the building being constructed had a roof on it. A meeting was called, the builders came out in force and said they couldn't do without sewer connections when cellars were being dug as they would not have any means of draining the cellars. The council ultimately agreed that the true solution of the difficulty was the construction of storm sewers and that until they were built it would be difficult to enforce such an ordinance.

Some builders had been using patented traps, allowing a surprisingly large flow of water to pass. It was found by observation in some houses that these traps worked steadily for days after a storm. Investigation showed that after careful inspection of the house connection by the health inspector, and following his departure when the floor was ready to be concreted the builder would proceed to tap a hole in the side of the soil pipe and cover it over with stone or a piece of tin. In some cases a trap or small sump was left in the floor to which the sub drains were led and the floor then concreted concealing what had been done.

Ten Times Normal Flow.—With a population of about 12,000, the normal sewage flow was approximately 1,000,000 gal. daily. This was measured by weir at the sewage plant and verified by the water company's records of consumption. During periods of storm, after the ground had time to saturate, the flow would increase to 3,000,000 and 4,000,000 gal. daily. In extreme periods, occurring once a year, perhaps more often, when the ground water level was high and frequent and continued storms occurred, the flow has reached as high as 10,000,000 gal. per day, though this was only of brief duration. As has already been shown, the 10,000,000 gal. per day flow was difficult to account for. All manholes were inspected and found tight; and practically all had tight covers. These covers in the spring time usually had a cover of tar over them; very few of them got water in them in that way. There were no weak points in the system. It was demonstrated that the flows from brooks, water-courses, leaders, etc., could not contribute more than half a million gallons of that flow and that the houses that had roof leaders connected to the sewers would not account for any large portion of that flow.

Analyzing the Abnormal Flow.—Analyzing the flow of 10,000,000 gal. daily the respective contributions were estimated:

(1) From normal sewage flow about 1,000,000 gal.

(2) Based upon the figures of Metcalf & Eddy as stated above, about 2,000,000 gal. might be allowed for infiltration in pipes.

(3) From the roof leaders and traps in the cellars about 500,000 gal. more.

Assuming the discharge into sewer connections from cellar subdrains through patented traps and openings in house connections to be about 1,500,000 gal. more, there would still be a considerable flow left, so the cellar excava-

tions were the only reasonable remaining sources left and it was assumed that the balance of 5,000,000 gal., possibly more, must be due to this. At that time about 250 houses per year were being built and the open excavations connected with the sewer and of houses under construction would number from 75 to 100. The observed heavy flow from several cellar excavations tended to confirm these findings.

It is strongly urged that where similar conditions exist they should be followed up and it is suggested that municipal engineers and maintenance departments study their flows, tabulate them, and check up on their house construction and connections to see that there is no misuse of such connections. It is probable that this is, in many cases, the main source of heavy flows and this is urged as the strongest argument for having the engineering department or sewer maintenance force take over the work of inspection from the health authorities who are not at all familiar with these problems. It is also suggested that it would be of great value to the engineering profession as a whole in the matter of design if such studies, where made could be carefully tabulated and presented for publication later.

In good practice a maximum of 250 to 300 gal. per capita is allowed in designing most systems and any flow beyond these figures endangers treatment plants and causes the waste of large capital expenditure when additional plants and new intercepting drains and outfalls are thus necessitated.

Results of Flooding.—Flooding of sewage systems results, in the first place, in undue tension in pipe lines, the joints of which are not designed to resist such internal pressure, the weaker joints giving away, and, in some cases, sewage will flow up over the surface of the ground, out through the manholes or back into the cellars. This backing up of sewage into the cellars is a serious menace. The effect of flooding on the treatment plant is that the bacteria, most delicate organisms, which under normal flows do wonderful work in the digestion of sewage, cease to function satisfactorily, sewage is not digested, and is discharged in a raw state into the streams where it consumes the dissolved oxygen in the stream, thus kills the fish and allows mosquito breeding, as one of the preceding speakers mentioned. Attention of the speaker was drawn to this by a game warden who had stocked with fish a pond lying below a sewage outlet; sediment from sewage flowing through the treatment plant in time of flood conditions which was practically untreated, had so used up the dissolved oxygen in the pool that the fish were unable to exist, and mosquito larvae not only thrived on the sewage but no longer were eaten by the fish as is normally the case.

Acknowledgment.—The foregoing is an abstract of a paper presented at the recent convention of the New Jersey Sewage Works Association.

Action of Currents on Floating Material

In order to determine to what extent pollution of shores and beaches might have been caused by the refuse deposited at sea by New York City, the Chief Engineer of the Board of Estimate and Apportionment made an investigation during the summer of 1926 by releasing a total of 7,433 bottles with return post cards enclosed. The returns from these have been analyzed and the results submitted to the Board of Estimate and Apportionment. These bottles were released in three lots on July 1, July 7 and July 27, respectively. The first of these was placed in the water at the strength of the flood tide, the second at the strength of the ebb tide and the third at slack high water. The point of discharge in each case was about 20 miles southeast of Scotland Lightship at the dumping ground used for city garbage. Up to June 30, 1927, a total of 2,419 bottles had been recovered and were picked up at the following destinations:

Up to the latter part of August, 1928, there had been 2,444 bottles recovered, including some on the coasts of Cornwall, France and Portugal. None had been reported at points along the Atlantic Coast to the east or north of Long Island.

Destination	Number Recovered	Per Cent
Long Island	909	37.6
Lower New York Bay	55	2.3
Staten Island	1	....
New Jersey	550	22.7
Delaware	186	7.7
Maryland	97	4.0
Virginia	345	14.3
North Carolina	257	10.6
At sea	14	0.6
West coast of Ireland	5	0.2
	2,419	100.0

Mr. Arthur S. Tuttle, the Chief Engineer of the Board of Estimate and Apportionment, drew the following conclusions from this experiment:

"The results of the experiment appeared to indicate that the normal action of the currents on floating material in open water outside of New York Harbor is seaward rather than landward, and that sustained landward winds are necessary to bring about the movement of any floating material from an off-shore point 20 or more miles distant to the adjacent mainland. From the information presented , . . by the Commissioner of Street Cleaning it appeared that practically none of the garbage dumped at sea would float indefinitely, and considering the time interval required for the floating bottles to reach the mainland, that under other than exceptional conditions floating garbage, moving as a rule much more slowly, would become water-logged and sink before it could reach the shore in any appreciable quantity."

Cost of Horse Maintenance at Toronto, Ont.

The Department of Street Cleaning of Toronto, Ont., during 1928 had 383 horses in service. The care of the horses is under the direction of a veterinary surgeon, whose services are engaged on a per capita basis of $4 per horse per annum. His duties are to render the necessary veterinary services to sick horses, advise as to the proper feeding of the animals, and take the necessary sanitary precautions against disease. He also examines and certifies as to the soundness of all new purchases, and condemns animals unfit for further service.

The average life of a horse in the service of the department is 6½ years. It is therefore necessary to purchase from 50 to 60 animals each year to maintain the standard. During 1928, 50 horses were purchased at an average of $231.

A card record is maintained of each horse as to date and from whom purchased, price, color, markings, age, height and weight. The time lost by horse, due to illness or other causes, is also recorded, as well as the date of disposition, cause, and sale price.

Cost of Feeding.—The average daily rations per horse, based upon the consumption during the year, amounted to 13.2 lb. of oats, 33 lb. of hay, and 0.25 lb. of bran, while in addition 0.1 lb. of other feed was given, consisting principally of salt, vegetables, etc. Each horse was also bedded with 4.4 lb. of straw daily, while the specific rational allotment is 15 lb. of oats, and 25 lb. of hay per horse per day. This amount in many cases varied according to the temperament of the horse. On Sundays and holidays, or in the event of horses standing in the stable, only light feeding of oats is given.

The purchase of fodder supplies is an important item. Every care is exercised to ascertain that all feed is of Government standard and free from moisture, dust, or must. The importance of this cannot be too strongly stressed in order to guard against the danger of heaves, colic, distemper, and other common diseases.

The following table shows the cost per day per horse:

	Average amount per horse per day			Cost per horse per day
Oats	13.2	at $ 0.677	per bus.	$0.262
Hay	33.2	at 14.38	per ton	.237
Straw	4.4	at 10.30	per ton	.023
Bran	.24	at 35 18	per ton	.005
Salt	.04	at 22.50	per ton	.005
Daily average number horses				381.6
Total horse days				139,671
Cost per horse per day				$0.527

We are indebted to the 1928 report of George W. Dies, Street Commissioner of Toronto, Ont., for the above information.

A Proposed Traffic Plan

Method of Providing One Way Traffic for City Streets

SOME time ago Alvaro Pratt, a retired civil engineer, of Los Angeles, Calif., submitted to the Traffic Commission of Los Angeles a plan for eliminating traffic congestion on the streets of the city. A gyratory plan, similar in many respects to that proposed by Mr. Pratt, has been placed in operation in London, England, in all the chief congested areas, like Trafalgar Square, Piccadilly Circus, Hyde Park Corner and Blackfriars. In most cases the main streets were turned into "one-way" streets which called for gyration, and although it added slightly to the distance to be covered by traffic, the speeding-up is stated to have been great.

A journey along the Strand, which used to average 15 minutes during the rush hours, is now stated to be frequently done in three to four minutes. Waits of four or five minutes, which frequently occurred at Trafalgar Square or Piccadilly Circus, are now practically eliminated.

The plan as proposed for Los Angeles is described by Mr. Pratt as follows:

"Traffic congestion in Los Angeles, today, is due to the attempt of two bodies to occupy the same space at the same time. The resulting conflict and confusion cannot be remedied by literary pleas for polite road manners, wider streets, multiplication of traffic ordinances, increasing violation penalties, or doubling the traffic squad. An automatically operating, and mechanically correct plan must be provided.

"This plan should require of the auto driver a minimum of skill, experience, ability, and knowledge of the law. Such a plan will be radically different from that now in use. Some interests will be affected adversely, or will fear so, and demand 'no change.' Public officials, rusted in the old ruts, will resent new ideas. The public will require a considerable educational effort—probably a year or more.

"Absolute paralysis of traffic is only prevented, today, by the employment of alternating curents of traffic. When one goes, the other stops. Each current starts from a stand-still. The maximum effective forward motion is about 25 per cent of that of a continuous stream.

"Left hand turns around a single center button reduce this efficiency one-half, while the vehicle is turning. This reduces the effective forward motion at a one button intersection to 12 per cent of that of a continuous stream.

"Continuous stream traffic can only be secured by the elimination of the right angle crossing, and the substitution therefore of traffic stream blending in the central portion of the blocks, instead of crossing at the corners. Collisions, on one way streets, would be rare, and would consist almost entirely of real end impact. Responsibility for this should be put entirely on the car that strikes. At night there would be no adverse glare of head or spot lights—in fact the stronger the light the better for everyone on the street. Pedestrian traffic would be safer, on one way streets, as the danger would be only from one side.

"The speed of the stream between corners should be not less than eight miles per hour. No vehicle should be permitted which is incapable of being operated at that speed. Motorcycles, bicycles and horses should be prohibited. The motorcycle and bicycle, because neither their speed nor direction can be estimated by others, nor can they slow up without stopping. The use of horses on city pavements is cruelty to the animal, blockades the bulk of the other traffic, and distributes horse manure over the surface of the street.

"Fire apparatus, hospital ambulances and police vehicles might have the same rights against adverse traffic as at present. When joining with one way traffic, no tie up would be possible in front.

"Traffic stream blending between corners can only be done on one way streets.

"One way streets with continuous non-stop traffic streams, require rotary traffic within a definite district.

"Rotary traffic must proceed from right to left, as seen from the inside of the rotary district. The area of the district may be one or more blocks. The district could always handle smoothly all traffic that could be delivered by the adjacent streets.

"The plan includes the territory from Temple to Seventh and Hill to Main:

"North bound traffic—Main and Spring.

"West bound traffic—Temple, First, Second and Third.

"South bound traffic—Broadway and Hill.

"East bound traffic—Fourth, Fifth, Sixth and Seventh.

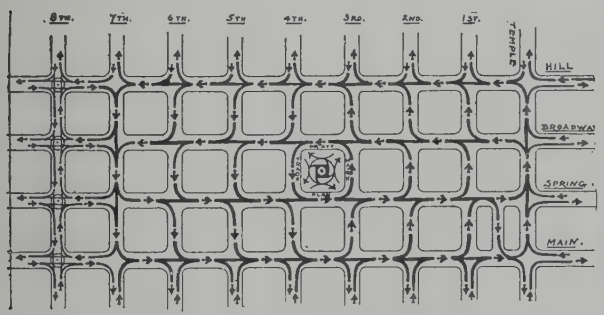

Diagram Showing How Motor Traffic Would Flow in One-Way Continuous Streams Through the Congested District of Los Angeles Under the Pratt Traffic Plan—North on Main and Spring Streets, South on Broadway and Hill, West on Temple, First, Second and Third Streets and East on Fourth, Fifth, Sixth and Seventh

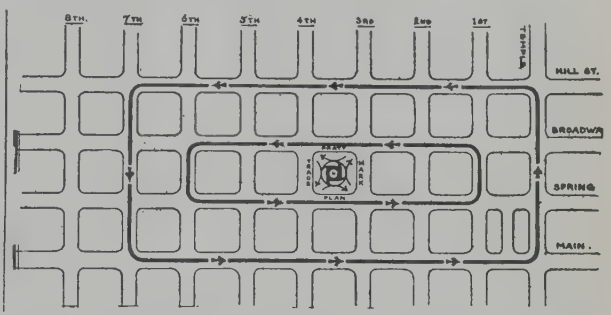

Diagram Showing Double Line Bus Routes Within Down Town Congested District of Los Angeles, as Provided in the Pratt Terminal Plan. Street Cars and Outside Motor Buses Would Stop at Terminals at the Outer Edge of the District and Their Passengers Would Be Taken Through the District as Indicated

"Tunnels and elevated ways on First from Fremont, and on Fourth from Figueroa, to Los Angeles St. will soon be necessary to carry through East and West bound motor traffic across Main, Spring, Broadway and Hill on separate grades.

"Street car traffic is possible within the rotary district, either as through service, or belt line loops. But a shuttle service from the suburb to the rotary district and return to suburb, would permit of accurate adjustment of number of cars to number of passengers; reduce by 50 per cent the "Lost Time" due to mechanical mishaps on through suburb to suburb lines, and eliminate the "Dead Time" due to traffic congestion for which congestion the street car itself is largely responsible.

"Full load terminals would reduce the car loading lost time by 90 per cent and substitute one stop for ten or more.

"Suburban traffic terminals, roofed and floored, on the edge of the "Outside Loop" would permit passengers to wait for, board or leave the street cars in comfort and safety.

"Street car and bus terminals should be located on private property fronting on the outer loop, with vehicular entrance from the next street over.

"Double belt line busses should then be provided by the street car and motor bus companies to carry their pas-

sengers without additional cost through the congested district, the busses moving with the other motor traffic around an outer loop consisting of Hill, Seventh, Main and Temple Sts., and an inner loop consisting of Broadway, Sixth, Spring and First Sts. These busses should have floor level with sidewalk, one door to enter, and one for exit, operating on the ordinary pavement with power to turn out for, or pass, each other, or other vehicles, and transfer passengers at reserved sidewalk, or street car terminal stations. No fares should be collected, cost of operation should be included in the street car fare from the suburb to the city; street car transfers being eliminated. Women, children and aged people could use the loop busses to cross intervening streets, when going in that direction. Pedestrians would presently get the rotary habit. Boarding or leaving a bus should not be more aggravating or dangerous than entering an elevator.

"The cost of construction of the plan would be probably 1 per cent, possibly 10 per cent, of the cost of either subways, or elevated railways. It would be superior to either, in the factors of flexibility of modification, cost of extension to new territory, effect on adjacent property, and stabilization of down town realty values. It would be more healthy than a subway, less offensive than an elevated, and could be abandoned at any time a superior substitute was found, with only a nominal loss of the capital invested.

"Parking: The parking or non-parking of automobiles does not effect the essentials of one-way streets, with continuous traffic stream flow. In fact, one-way traffic, of a single line, along the center of the street, would accommodate double the vehicles carried by any double line street today.

"Frontage interests will, in the final issue, determine parking, each section according to its views of its own interests—period, parallel, 90 deg., 45 deg., or none. Frontage owners today are obsessed with the idea that parking means good business, non-parking poor business, regardless of the fact that an average six-story building on a 50-ft. lot only affords parking at the curb for two cars. The shops and offices above contain from 100 to 200 clerks and professional people. Half of them have their own cars, say 100. Half of the prospective clients and customers are supposed to have cars, making a total of 200 cars to be parked. Parking capacity equals 1 per cent.

"There being, only 1 per cent enough room in the street, it is obvious the complete parking must be done on private property, if at all. Parking is mechanically feasible only on the ground floor. The shopping level might move bodily upstairs, and front on elevated or arcaded sidewalks, displacing the office tenants of the second floors, leaving the ground floor and present sidewalk areas for parking.

"Elevated side and cross walks would remove the pedestrian from the path of automobiles. The second floor would yield greater floor space, better light and be much cleaner than the present ground floor for the display of merchandise. But previous contracts, leases, and tenures, render it practically impossible for the downtown districts to avoid being abandoned by the automobile patron."

Water Supply and Sewerage in Environs of New York City

The recently issued report of the Committee on Regional Plan of New York and its environs, contains the following information on the provisions (as of Jan. 1, 1927) for water supply and sewerage in the principal communities in the environs of New York City.

Several of the communities obtain their water from two or more different sources. In New Jersey particularly there are many inter-connections between various sources of supply which have complicated the problem.

Of 330 communities in the environs which had public water supplies at the beginning of 1927, 291 were political subdivisions while the remaining 39 were nonpolitical units. There were several other small districts, mostly unincorporated, which were supplied to a certain extent by private water companies.

There were in all 150 sewage treatment plants in the environs serving the 205 communities with sewer systems. Adding the 17 plants within New York City makes a total of 167 plants in the Region, only 40 of which included some form of oxidizing treatment.

It is interesting to note the geographical distribution within the Region of the various sewerage and water supply facilities in the environs. Grouping these under the three states from parts of which the area is comprised, the following sewerage figures were obtained:

	New York	New Jersey	Connecticut
Number of communities listed	107	209	14
Those with sewer systems	60	138	7
Those with sewage treatment	39	101	6

All of the communities listed had some type of public water supply. Grouping them under a similar geographical distribution, the following figures for water supply were obtained:

	New York	New Jersey	Connecticut
Communities with municipally owned sources of water supply	47	72	8
Communities with privately owned sources of water supply	60	137	11

A summary of the sewerage and water supply figures for all of the environs is as follows:

Number of communities listed	330
Those with sewer systems	205
Those with sewage treatment	146
Those with municipally owned sources of water supply	122
Those with privately owned sources of water supply	208

Including in the water supply statistics the sources which have been developed within the limits of New York City, there was within the entire Region a total of 79 principal developed sources of surface water supplies. Of these, 45 or 57 per cent were municipally owned and 34 or 40 per cent were privately owned. There was also in the Region a total of 176 principal well stations where ground water supplies were developed. Of these, 102 or 58 per cent were in municipal ownership and 74 or 42 per cent were in private ownership.

Standing Committee Recommends Addition for Simplified Practice Recommendation on Paving Brick

Because of the increased demand for an eliminated size paving brick, the Permanent Committee for Simplified Practice Recommendation No. 1, Vitrified Paving Brick, has recommended to the industry that the wire cut lug brick (Dunn) 3x3½x8½ be reinstated as a standard type, according to the Division of Simplified Practice of the Bureau of Standards, U. S. Department of Commerce.

This size brick was eliminated from the recognized standard sizes on March 20, 1925, but the shipments for this size during the past three years has gradually increased until today it represents 14.5 per cent of the total based upon the survey of the industry in 1928. By the inclusion of the size into the simplification program, the Division of Simplified Practice stated that the degree of adherence to this recommendation is increased from 70.1 per cent to 84.6 per cent. There are now six standard, or recognized sizes of vitrified paving bricks.

In making this announcement the Division of Simplified Practice pointed out that the paving brick simplification was one of the initial projects developed by industry under the cooperation of the Department of Commerce. Much of the success attained by the program has been due to the support it has received from the Standing Committee and the National Paving Brick Manufacturers' Association.

The Division of Simplified Practice is the only organization engaged in waste elimination, through simplification and standardization, that subjects the effected programs to stipulated review, in order that they may be revised or modified in order to keep them abreast of current developments in the industry.

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The Cause of the Severe Winter Weather of 1928-29

Eleven years ago there occurred an exceedingly severe winter. History has just repeated itself, but doubtless some of the "frankly skeptical" astronomers will remain "frankly," although perhaps not so loudly, skeptical about the influence of sunspots on weather. It is no easy matter to change a scientist's mind once it has been well coagulated by a false doctrine.

There is a great sunspot cycle that reaches its maximum in number of spots about every 11.2 years, and it has been doing this with remarkable regularity ever since astronomers began counting sunspots about three centuries ago. On several occasions since those counts began (9 to be exact) the sunspot maximum did not occur within 18 months of the time that the so-called 11-year maximum was due. But on the remaining 20 times out of the total of 29 (counting from 1615 to 1928) the 11-year spot maximum came very nearly on time.

In the October, 1928, issue of "Municipal News and Water Works," an article gave the results of a long research by the editor as to the cause and periodicities of sunspots. In that article many sunspot cycles were listed, and each of the 8 planets was credited with a cycle; the date of the last maximum and the exact length of each cycle was given, so that anyone could check the results on a chart of the sunspot curve. A table was printed showing the dates of each of the 28 sunspot maxima from 1615 to 1917, and the dates of maximum sunspot influence assigned by the editor to Jupiter, Uranus and Neptune. It was shown that Jupiter, the largest of 8 planets, is responsible for the spot cycle of 11.21 years; when Jupiter's north magnetic pole points most nearly toward the sun, then Jupiter creates the most spots. Each of the other planets produces its maximum effect in a similar way; and because the magnetic poles of their upper magnetic fields are all revolving westward about their axes of rotation, the sunspot cycles that they cause are invariably shorter than their periods of orbital revolution. It was shown that 3 different times when a great sunspot maximum did not occur on or near a date assigned to Jupiter, it did occur on or near a date assigned either to Uranus or Neptune, those two planets evidently having more powerful electromagnetic effects upon the sun because their axes point much more directly toward the sun.

Since the next peak effect of Uranus is not due till 1951, and that of Neptune not till 1998, it was shown that Jupiter's 1928 sunspot peak would not be interfered with by either of those planets, and that the Jupiter peak would occur about Nov. 1, 1928.

Sunspots having anti-clockwise rotation are the main causes of our cyclonic storms. Nearly all storms are cyclonic, and in their whirling nature they are closely kin to the sunspots by which they are caused. Sunspots are known to be electromagnets (due unquestionably to the free electrons in the whirls), and the editor has reasoned, both by analogy and deductively, that our cyclones are electromagnets, electrically generated, electrically whirled and electrically propelled. He has been able to explain cyclonic phenomena far better by this theory than it has been previously explained by a combination of theories in which convection currents and centrifugal force are supposed to play the star roles.

Storm tracks (i. e., the paths of the centers of cyclonic storms) are often parabolic. This discovery was based on the electromagetic-whirl theory, and is explainable by no other theory. In fact it was not perceived by meteorologists because their theories did not guide them to look for it.

Storm tracks shift to higher latitudes during sunspot peaks, and thus produce weather anomolies. It is such anomolies that have puzzled many astronomers and have led some of them to express skepticism about the influence of sunspots on weather. One very cocksure astronomer has wittily said that predicting weather by the aid of sunspots is like trying to forecast which way an elephant will walk by studying the migrations of a tick on the elephant's ear. It may be replied that predicting weather far ahead without the aid of sunspots is as futile as to try to calculate planetary interactions unguided by a knowledge of gravitation.

The statistical literature showing quantitative relationships between sunspots and weather is already prodigious. Its very bulk apparently deters most astronomers from even glancing through it. The seeming inconsistencies and anomolies with which this literature abounds are even more forbidding. But in every other case where quantitative relationships have been discovered, diligent study has led to an untangling of the maze and a disclosure of the underlying simplicity of the phenomena.

The Tensile Strength of Water

When capillary attraction was first discovered it was thought that the answer had been found to the question, Why does sap rise? But capillarity was soon found to be inadequate. Later came the discovery of osmotic pressure, and again it seemed that the answer had been secured. Physicists have finally concluded that no forces known to act upon sap can account for a rise of more than about 150 ft., yet it rises more than double that height in the tallest trees.

Prof. H. H. Dixon, of the University of Dublin, has recently proved that water in capillary tubes has a tensile strength of several hundred pounds to the

square inch. Since this would suffice to lift a capillary column of water to the tip of the tallest tree, he has inferred that evaporation of the water in the leaves furnishes the lifting force. He becomes rather vague in trying to show how evaporating molecules exert a pull on the surface of water that they are leaving.

When a liquid evaporates it expands into gas, and gas would presumably exert a back pressure on the surface of the liquid, instead of a pull upon that surface.

The thought has occurred to us that when water in a capillary tube acquires tensile strength, it may be because some of its electrons are rotating in planes perpendicular to the axis of the tube. Each electron rotating in this manner would constitute an electric current, and since parallel electric currents attract one another, tensile strength would be produced in the column of water. The water column would resemble a magnet, and in fact would be a fluid magnet.

Such a magnet might then be forced up by the magnetic field of the earth, just as air in cyclonic air-whirls seems to be forced upward. And thus a more complete explanation of the phenomenon of the ascent of sap would be had.

Although there may seem to be no way in which the hydraulic engineer can utilize such a principle, let us not be too skeptical of our inability to apply it. It is evident that ways can be devised for releasing more electrons in water. Ultraviolet light, for example, effects release of electrons, and we are convinced that magnetic fields effect release of electrons. Picture, then, a pipe of small diameter into which highly electrified water is introduced at the base under the influence of a magnetic field that gives rotation to the electrons about the axis of the pipe. It is probable that the magnetic field of the earth would lift the water to a considerable height, and thus furnish the lifting energy free of charge.

What plants have learned to do on a small scale, engineers should be able to do on a large scale. The first step, however, consists in securing a full understanding of the reason why sap rises to the top of giant sequoias.

Hats Off to the Jack-Of-All Trades

Upon a time not so long ago, to be dubbed a jack-of-all-trades was to be labeled a worthless fellow. Perhaps the day is not far distant when that term will be regarded as one expressive of the highest approval. Ability to shift quickly from one occupation to another characterizes so many American workers as to have attracted the attention of some foreign visitors, but we do not recall reading that any of them saw in that versatility one of the main reasons for the economic progress that they envy.

Recently an English periodical published an account of the woeful experience of a shipyard worker who has been out of a job for several years, living on a small dole. The most instructive part of the tale was unintentionally written between the printed lines; for, although never explicitly stated, it was tacitly assumed throughout that the misery of this man would not end until ship construction again reached a degree of prosperity sufficient to give him back his lost job. While there are still some American workers who would thus wait years for their lost jobs to return, their number is relatively few, and steadily decreasing. A shipworker today, a farmer tomorrow, a truck driver the next day, and any old job thereafter, may not seem like good training for the man aiming at high wages, but none the less it has resulted in the highest average wages in the world.

Of course the prime reason for American high wages is great productivity per worker, and this is first of all due to science and invention; but neither science nor invention can operate effectively in the service of man unless there is freedom to apply the discoveries that they yield. In countries where workers regard themselves as irrevocably tied to their particular trades, it is not surprising to find it very difficult to introduce labor-saving devices. When a man feels that if he loses his job as a riveter in a shipyard and no other sort of job can be had, that man is sure to oppose any device that will enable men to drive more rivets; and if riveting were to be replaced by welding, well—! Great Britain is full of just that sort of men, with just that sort of attitude toward their jobs. The world war served to strengthen that attitude, and the dole was a political device that made the typical British worker more determined than ever to cling to the old tradition. No jack-of-all trades, he.

So long as most products were handmade, and required a deal of skill in their production, a shifting from one sort of trade to another was almost prohibitive. With the advent of machines in which the skill of the worker had been superseded by the "skill" of the mechanism, there suddenly came a change, or at least it would have come suddenly had not habits been of a stuff that changes slowly. The built-in-skill of the machine meant more freedom for the worker, freedom from years of apprenticeship at beggarly wages, and what is much more important, freedom to shift from one machine-tending job to another almost over night. This last-named freedom explains, in large measure, the absence of strong opposition to labor-saving devices in America.

British investigators come, and see, but do not comprehend. They go back with talk about "mass production," "high wages as a cause of great demand," and the like, but they fail to see that freedom is the one great factor that British industry lacks. There must first come a different outlook upon the job, the outlook begotten of knowledge that machinery can be used to free men from the tyranny of industrial caste, and there must come faith in a future where such freedom exists. This outlook and this faith are not to be created by any fiat, nor even by the most logical arguments. Outlook and faith are unfortunately matters of slow development; but the development can undoubtedly be hastened by judicious oft-repeated presentation of facts. America furnishes the facts without limit, but apparently they need to be interpreted to other nations; for even the men who come looking for them, leave without recognizing the most important fact of all, namely, industrial freedom.

H. P. Gillette

New Books

"Economics of Highway Bridge Types" by C. B. McCullough, Bridge Engineer, Oregon State Highway Commission; Member American Society of Civil Engineers; Member Oregon Bar; Special Lecturer in Structural Engineering, Oregon State College. First edition, 246 pages, 5¾ in. by 8½ in., hard cover, cloth binding; Gillette Publishing Co., Technical Publishers, 221 E. 20th St., Chicago, Ill., publishers. Price $5.00 net.

You have often heard the expression, "He could not see the forest because of the trees." The function of this book is to place the reader on a hill or in an airplane, as it were, to survey the forest. In other words, McCullough analyses the crossing problem from the broad viewpoint of selecting an economic type of bridge from amongst the many types that may be constructed.

This text has been compiled with a view to its utility not only to the practicing highway engineer, county engineer, city and consulting engineer, but to the undergraduate student in highway and civil engineering as well.

A prominent feature is the fact that the discussion has been prepared for the highway engineer in general rather than the highway bridge engineer.

The many cost and quantity curves and data sheets have been made sufficiently general in application to cover average practice and govern estimates of cost of structures designed according to general practice. The tables and curves should prove of great benefit to the engineer in the field engaged in highway location or relocation, to highway maintenance engineering organizations and to field parties, divisional organizations, municipal and county engineers and others engaged in the construction, location or design of highway bridges.

To the student in engineering this work should serve a two-fold purpose. First, as an outline of bridge economics and type selection in general it serves to direct his attention to a most important phase of bridge engineering and one to which scant time is given in most engineering curricula. Second, the many cost tables, curves and illustrations, covering in fact practically all of the commonly employed types in highway bridge construction, will serve to give him a rather thorough and comprehensive survey of the ordinary construction types, these affording him an opportunity to develop the necessary and much to be desired general perspective of the subject before taking up the complicated minutia of design and design methods.

"Prometheus, U. S. A." by Ernest Greenwood, author of Alladin, U. S. A., etc. First edition, 213 pages, 5½ in. by 8⅛ in., hard cover, cloth binding, illustrated, Harper & Bros., New York City, publishers. Price $2.50.

Beginning with the tales of fire as they are chronicled in myths, legends and the history of its uses down through the ages, Mr. Greenwood considers at some length the modern methods of uses of fuels and their relative merits in industry and home. He has collected a large amount of material on oil, gas and electric light and power and has been able to sketch the picture of the distribution of these agencies for their multitudes of present-day employments. "Automatic heat," he summarizes, "is the latest achievement of man in employing fire for his comfort and for industrial purposes."

Wood is referred to as the first fuel and one of the bulwarks on which this country was built. Facts are given on the supply of wood now available and what is being done to assure a continuing supply for future generations, pointing out that wood is no longer to be considered as a major fuel.

In summarizing the part that coal has played in the history of fuels, the author says,

". . . to coal goes the credit for building the very foundations of American industry and it will be a long, long time before it is entirely replaced by oil, water power or some synthetic fuel of the future.

"Without coal, our transportation system, the greatest in the world, would still be in its early stages of development. Coal was an important necessity in the smelting of iron so necessary for the rails and the equipment of our railroads. Coal was the only kind of fuel that was available in the early days; how far would our railroads have travelled if they had had to depend on wood? Coal was an absolute necessity to run the industries which eventually produced the machinery from which our water-power generating plants are built."

Following this, the gas industry is discussed, Mr. Greenwood citing instances of its early discovery and the difficulties that attended its commercial introduction in the last century in England and America. He includes a considerable amount of statistical information about the industry as it exists in this country today, pointing out that, as is the case with the light and power companies, gas companies necessarily are monopolies in the communities they serve. Other sections of this discussion deal with who owns the gas companies; coal as direct fuel and as raw material for making gas; coke and other by-products.

About automatic heat, as it is supplied by the modern oil burner or the modern gas heater, he says; in part: "There are many things of social significance which are accomplished by automatic heat aside from pushing into the background another piece of the ugly machinery of life. The growing desire for apartment house life is due, to a considerable extent, to the dread of the furnace in the basement. No one who has ever tried it will deny that the private house provides a far more satisfactory home life, particularly when there are children, than the apartment, which at best always has something of the atmosphere of a hotel and which almost always lacks the comfort of spaciousness to be found in even the most humble of dwellings."

"Prometheus" is easy to read. And it is a welcome addition to the library of popular books dealing with Industrial America.

"The Arithmetic of Sewage Treatment Works," by Karl Imhoff, Chief Engineer, Ruhoverband, Essen, Germany; Member American Society of Civil Engineers; translated from German by G. M. Fair, Asst. Prof. of Sanitary Engineering, Harvard University, Cambridge, Mass. 99 pages, 4½ in. by 7 in., flexible binding. John Wiley & Sons, New York City, publishers. Price, $2.00.

This little book is intended to assemble in small space the methods of computation commonly employed by sanitary engineers in the design of sewage treatment works. Statements of methods have been made brief. Exact mathematical calculations do not lead very far in the design of sewage treatment plants because the methods are based on practical experience.

"Financing of State Highways," compiled by Julia E. Johnson. First edition, 209 pages, 5 in. by 7½ in., cloth bound in hard cover. The H. W. Wilson Co., New York City, publishers. Price. 90c.

This book is based primarily upon the issue of bonds for highway purposes. It includes discussion of the sources of taxation to be drawn upon for financing and such practice, principles and breadth of discussion as abstracts permit. It is compiled from abstracts as shown in the bibliography and arranged for debating purposes.

"Building Estimators' Data Book," by Chas. F. Dingman, Architectural Engineer. First edition, 159 pages, 4 in. by 6½ in., flexible binding. McGraw-Hill Book Co., New York City, publishers. Price, $2.50.

This little volume is an addition to Mr. Dingman's other works and contains all of the estimating data that appeared in the other book, as well as more new and original material. The data is condensed and tabulated for ready reference, using the unit system of estimating.

A list of standard symbols for wiring plans is included.

"Masonry Dams," by William P. Creager, C. E., Member American Society of Civil Engineers. Second edition, 294 pages, 6 in. by 9 in., cloth bound, hard cover. John Wiley & Sons, New York City, publishers. Price $4.00.

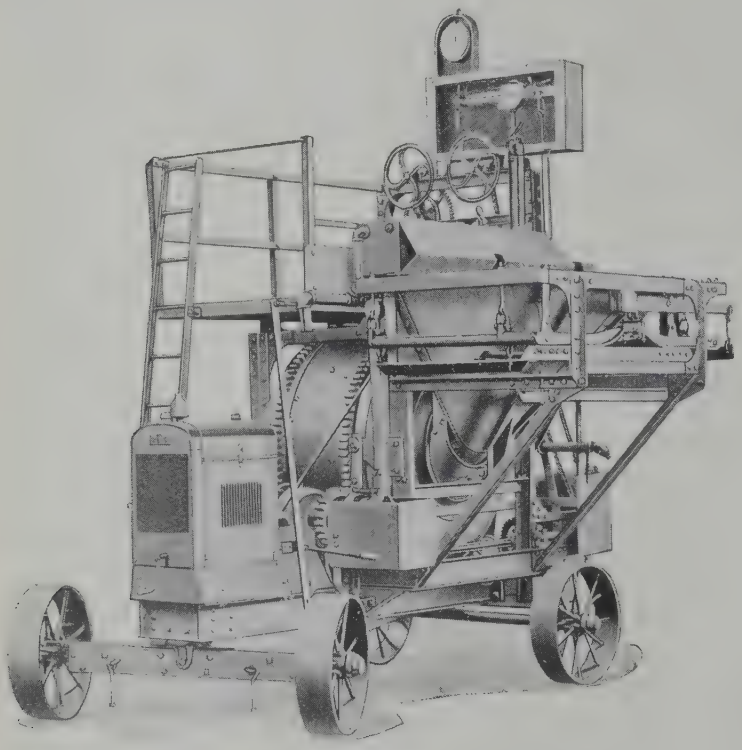
This is a review of the text of the first edition with obsolete matter removed, new material on newer developments included.

The book includes diagrams for quantities in solid gravity dams, backwater computations, fuller description of outlet control and flood gates and new chapters on arch dams and flood flows. Like sewage treatment engineering, this branch of civil engineering is based largely on practical experience and data learned from failures. The theory on which the design of masonry dams is based, the author acknowledges, is not exact, and, moreover, has not been verified by satisfactory experiments.

A New Mixer Attachment Weighs Water and Aggregate

A new mixer attachment called the Weigh Mix was recently developed by the Koehring Company of Milwaukee, Wis., manufacturers of pavers, mixers, power shovels and cranes.

This machine was brought out in response to a desire by contractors for a portable concrete manufacturing plant that could be charged with available equipment and which would be capable of accurate proportioning of materials by weight.



Weigh Mix Attachment for Standard Koehring Mixers

The Koehring Weigh Mix satisfies these requirements and fulfills the needs of the building contractor. It consists of a standard Koehring mixer, equipped with a weighing batch hopper and water tank mounted on an auxiliary frame carrying pipe lever scales.

All operations are controlled from the operating platform by one man. Materials are weighed into one hopper, thereby allowing for the use of as many aggregates as may be desired; gravel is normally weighed in first, followed by cement and sand; the water is weighed on the same beam and is carried in an open tank.

When the batch hopper door opens to allow for the charging of the mixer, the batchmeter is actuated and the hopper shaking device, operated by a cam on the main driving shaft, is started. The batch hopper discharges quickly, cleaning perfectly so that the scale will return to balance.

By mounting the weighing batch hopper on the mixer, head room is reduced as compared to the use of independent weighing or measuring devices. This allows a compact arrangement of controls for one-man operation. Due to the shape and position of the hopper, bulk cement and any number of differently graded aggregates can be weighed without additional equipment.

The batch hopper does not come in contact with the weighing mechanism while being shaken and therefore the accuracy of the weighing mechanism is not affected. The scale beam is boxed so that it can be taken off the plant for transportation, thereby insuring against damage.

The Koehring Weigh Mix is practical in design and is successful in operation. Although new, it has already attracted favorable attention from engineers and contractors who have been in touch with its operation.

Upon request the Koehring Company or any of its sales offices will send a special circular describing the Weigh Mix.

Cast Iron Pipe 18 Ft. Long Now Manufactured

Eighteen foot lengths of deLavaud centrifugal cast iron pipe in all diameters 4 in. to 12 in. inclusive has just been announced by the U. S. Cast Iron Pipe & Foundry Co.

A battery of casting machines for the production of deLavaud pipe in 18-ft. lengths is now in operation at Birmingham, Ala. and the product will be found to measure up in every respect to the high standards established by deLavaud centrifugal pipe in 12-ft. lengths.

The advantages of 18-ft. pipe can be readily visualized when it is considered that as compared with 12-ft. lengths of pipe there is a reduction of 33⅓ per cent in the quantity of jointing materials required, in the labor of making the joints themselves and digging the bell holes. In the construction of plain end pipe lines for gas the use of 18-ft. lengths reduces the cost of couplings, or special connecting pieces, 33⅓ per cent and correspondingly reduces the labor involved in the installation of such couplings or special connecting pieces. Another feature is that with the longer lengths that are fewer number of joints which reduce the number of possible points of leakage in the finished line.

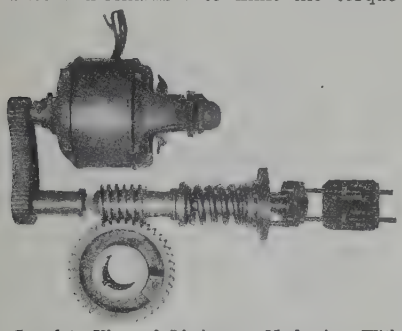
The equipment for handling the 18-ft. lengths of deLavaud centrifugal pipe need be no different from that used in handling 12-ft. lengths of cast iron pipe. For example, the standard weight of an 18-ft. length of 8-in. Class 150 deLavaud pipe, used for 150 pounds maximum working pressure, is 629 pounds. Compare this to the standard weight of a 12-ft. length of 8-in. Class C, sand cast pipe used for 130 pounds maximum working pressure which is 625 pounds; in other words, while the 18-ft. deLavaud pipe is 6 ft. longer than the 12-ft. Class C sand cast pipe, it allows an additional working pressure of 20 pounds and weighs only 4 pounds more.

On account of the decreased weight per foot, as compared with the same diameters of sand cast pipe, the same number of men can be used to install 18-ft. lengths of deLavaud centrifugal pipe as are used for the installation of 12-ft. lengths of sand cast pipe.

Loading Car with 18-Ft. Cast Iron Pipe

Limitorque Improved

The Limitorque Corporation, New York City, have developed a mechanism for operating valves, doors, etc. It is a reversible motor driven reduction gear valve controller with a mechanical switch mechanism to limit the torque



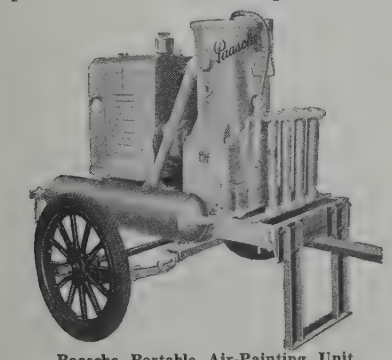
Complete View of Limitorque Mechanism With Case Removed

and travel of a slow speed shaft in both directions. Power may be electricity or compressed air, remotely controlled.

It operates through one pair of heavy grease lubricated worm gears, in an oil tight casing. The manufacturer states that Limitorque has a torque switch that stops the valve gate only when it is properly seated, regardless of travel. The valve gate may be closed to any desired degree of tightness. All seating and unseating strains are absorbed by a heavy compression spring. A positive unseating blow is administered at slow speed directly to the valve stem nut.

Air-Painting Trailer Unit Announced

The Paasche Airbrush Co., Chicago, Ill., announce the production of a new Paasche air-painting unit, a two-wheel trailer—new in design—that goes anywhere. It is equipped with a 64-ft. patented water and oil operator that



Paasche Portable Air-Painting Unit

removes water, oil, dirt and moisture from the airline, thus assisting in producing a better finish.

Paasche air-painting units, the manufactures claim, are the only portable units equipped with these patented water and oil separators.

New Pump Operated by Outboard Motor

A new type drainage pump, which is powered with a Johnson outboard motor and which is unique in that it is self-priming and will shut itself off when the water being pumped is stopped or gone, is now being manufactured by the Johnson Motor Company, Waukegan, Ill.

This pump consists of a long pump shaft with a light twin-cylinder outboard motor mounted on the top. This motor powers the impeller which is located at the bottom of the shaft. As the pump shaft sinks to the bottom of the water and the impeller is always submerged no air can be sucked while there is still water to be pumped. Thus delays in priming are eliminated. In addition starting difficulties are also eliminated as the water begins to flow immediately after the motor is started.

The automatic shut-off prevents the pump from burning out on the job. A

Johnson Portable Pump

workman can start it and can go away and forget it, for an ingenious safety device short circuits the magneto of the motor when water is not passing through the pump.

Some types of work to which this outfit is adopted includes pumping water from excavations, concrete forms, manholes and barges. It is also found highly useful in dredging work of all kinds.

It will pump 195 gal. of water per minute and 1,000 gal. for the approximate cost of one cent, according to the manufacturer. It can do in five minutes what would require an hour and a half for one man with a hand-operated pump and will do with a half gallon of gasoline what another unit may do on a quarter ton of coal, it is claimed. The outfit weighs 85 lb. and can be carried by a man.

Further information about this new pump may be secured from J. H. Sheldon, Johnson Motor Co., Waukegan, Ill.

A New Sewer Pipe Joint Material

The Standard Oil Company of Indiana announces an asphaltic product for making leak-proof sewer pipe joints. The product is known as No. 1 Korite (Brand 6775). No. 1 Korite is said to make a permanent, tight joint, and to prevent the leakage, infiltration and choking of pipes by roots. It is quickly prepared for use, and easily applied by an intelligent laborer.

It has been used on sewer pipe installations in various localities. Tests conducted by the engineers of the Clay Products Associations have proved that the No. 1 Korite is a satisfactory material for making a permanent, leak-proof joint.

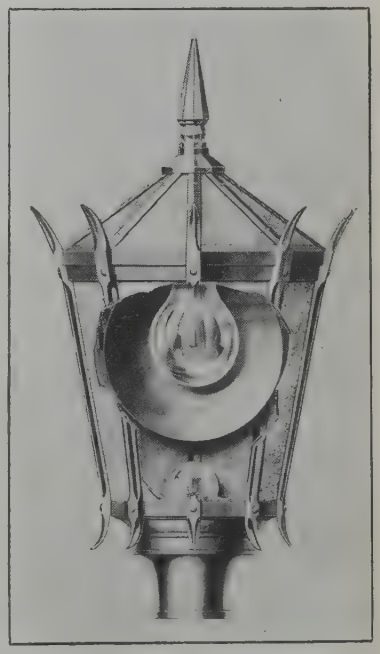
Copies of the No. 1 Korite folder, describing this product may be had by writing to C. C. Lakin, Manager of the Asphalt Department, Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois.

Ornamental Floodlights

The King Luminaire Company, 37 West Jackson Boulevard, Chicago, have added ornamental floodlights to their wide range of ornamental industrial lighting equipment.

King Luminaire floodlights are unique in that the floodlight reflector and lamp are enclosed in a King Luminaire ornamental lantern, eliminating the unsightly reflectors that have been used in the past, thus serving the dual purpose of a floodlighting lantern, plus the ordinary illuminating functions.

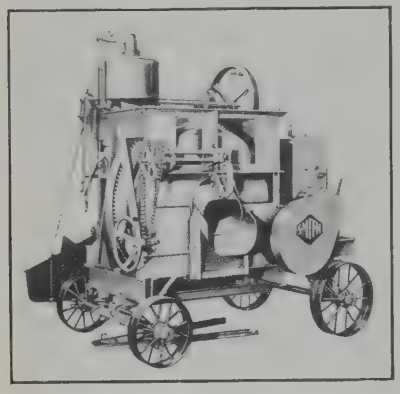
King Luminaire floodlights may be had in a wide range of designs and sizes to meet the most exacting needs and tastes. Industrials interested in illuminating and beautifying buildings and grounds can secure literature by writing Mr. O. M. King, President, King Luminaire Company, 37 West Jackson Boulevard, Chicago.



King Luminaire Floodlight

A New Half-Yard Mixer by Smith

The T. L. Smith Company, independent division of the National Equipment Corporation, and mixer builders for the past 30 years, are now



Newly Designed Smith 14-S Non-Tilting Mixer

introducing a new 14-S non-tilting mixer said to be unusually simple in construction and fast in operation.

The drum is of typical Smith design, bigger in diameter and narrow, with 10 deeper full-width discharge buckets and bigger drum openings than former models. It is claimed that these drum improvements permit the use of a wider-throated skip and wider discharge chute, time saving features that assure quicker loading and faster discharge. Complete front end operation is provided, with both charge and discharge sides of the mixer visible. The drum rollers are equipped with oversize Timken bearings in dust tight housings.

Other features include: pressed steel drum heads, short swinging discharge spout and auxiliary stationary spout, band friction hoist clutch and brake, low hot-riveted frame, forged steel rear axle brackets, and wheels that turn under the frame for easy handling. Optional equipment includes a newly designed batch hopper with large swinging gate.

Arco Metal Pipe Enters Water Works Field

Arco metal pipe is a threaded joint corrosive—resisting high quality cast pipe made of alloy iron. It can be cut and threaded at any point within its own length with all standard tools which are used on wrought steel or iron pipe and does not have to be reamed after cutting.

The following statements are made by the manufacturer, the American Radiator Company, New York City:

1. It is true to dimensions, smooth outside and inside.
2. It is free from casting stains
3. It is uniform in wall thickness.
4. All standard floor tables for extra strong wrought steel and iron pipe can be used to figure the capacity of Arco metal pipe.
5. It is resistant to both corrosion and erosion and will not scale inside.

Arco metal pipe is made from a special analysis ni-chrome alloy iron and cast by a process which gives the resultant greater ductility and tensile strength, and also, due to the close grain structure, greater corrosion and erosion resisting qualities than ordinary gray cast iron.

Arco metal nipples and fittings are made for use with the pipe. The pipe is made in sizes from 1½ in. to 6 in. inclusive.

Dietz Announces Roadside Torches

To satisfy a certain amount of demand for roadside torches, which are legal in some states for highway construction work, the R. E. Dietz Company has recently introduced two models. No. 96 is a spherical torch having a weighted bottom which causes it to return to position if tipped or

New Dietz Roadside Torch—No. 96

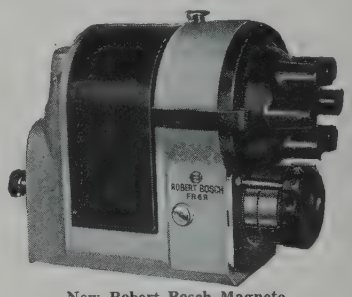
knocked over, while No. 80 is a semi-special torch with a broad, stable, unweighted base and curving sides that operates as a fend against injury. These torches burn either kerosene, light fuel oil or crude distillate. Each is provided with a cast steel burner, heavy carrying loop and an automatic lock that prevents the wick from slipping. They are packaged three in a carton and distributed through the jobbing trade exclusively.

For further information write the R. E. Dietz Co. of New York.

Robert Bosch Announces a New Super-Energy Magneto

A new magneto for 6-cylinder engines has recently been announced by the Robert Bosch Magneto Company, Inc. This instrument, known as type FR6, is designed especially for use on truck, bus, marine, stationary and similar engines where large cylinder capacity or high compression make a powerful magneto desirable. The general appearance of the type FR6 magneto closely resembles that of the Robert Bosch FU type. The chief apparent difference,—besides its slightly larger size,—is the distributor plate which has the high tension outlets at the front instead of at the top. Generous margins of safety are provided to take care of the high voltages developed. The collector ring and certain other electrical parts have been increased in size.

The type FR6 magneto generates an



New Robert Bosch Magneto

igniting spark at 30 crankshaft r.p.m. This insures an effective starting spark even at the slowest hand crank speeds. It is recommended for engines operating normally up to 3,000 r.p.m., which covers practically the whole range of commercial engines.

This magneto has all the features characteristic of Robert Bosch Super-Energy magnetos, which have proved highly successful under all sorts of operating conditions. These features include permanently lubricated ball bearings, gap type distributor, dust proof and water proof construction and one piece aluminum alloy frame.

Sidewalk Snowplow Announced

La Plant-Choate Manufacturing Co., Cedar Rapids, Iowa, has just built a side walk snowplow for crawler tractors. It is the answer to the side walk clearing problem in the snow belt where horses are too slow. Write the factory for a catalog or call on some dealer for information.

Sidewalk Snow Plow by La Plant-Choate

Municipal News and Water Works

Vol. LXXVI JUNE, 1929 No. 6

The 1929 Convention of American Water Works Association

49th Annual Meeting Meets June 24-28 at Toronto, Ont.

THE 49th annual convention of the American Water Works Association, which is to be held June 24-28 inclusive at Toronto, Ont., will be one of the most important meetings ever held by this association. Action will be taken at the convention on the adoption of a new constitution for the association.

Royal York Hotel, Where 49th Annual Convention of American Water Works Association Will Be Held

The New Constitution. — The new constitution, the result of a year's deliberation by a committee appointed at the 1928 convention. Its main feature is the formation of a board of directors, which will have full control of all activities of the association. The board will appoint all committees and provide for the general administration of the affairs and property of the association.

The board of directors will consist of the president of the association, the treasurer of the association, the latest living past president of the association, the chairman of the committee on water works practice, the chairman of the publication committee, one director elected by the members of the Water Works Manufacturers Association, and one director elected by each section of the association. This later representation means that every part of the territory covered by the association will have its representative and will have a part in formulating and executing the policies of the association.

The board of directors will meet each year at the annual convention and it is also proposed to have a meeting in January of each year at which all the directors will be present. In order to give continuity to the board membership the term of the directors representing the sections will be so arranged that approximately one-third of them will retire each year.

The new constitution also provides for an executive committee consisting of the president and four directors, which will direct the administrative work of the association and carry out the policies of the board between meetings of the latter. This committee will be chosen by the board at its meeting at the annual convention.

Provision also is made in the new constitution for additional conventions or regional meetings, but such meetings are only to be held as found advisable. In general, they would be held when and as desired by the sections in any portion of the territory covered by the association.

The Convention.—The headquarters of the convention will be at the new Royal York Hotel, which was officially opened on June 11. The entertainment which will be given at this convention includes a reception and dance the opening night, theatre and card parties, bus rides, tea at the Yacht Club and a shopping tour for the ladies; smoker for the men and a dinner dance for everyone on Thursday evening.

The delegates will be given an opportunity of inspecting the water works system of the city of Toronto and trips to the different stations and filter plant will be arranged upon registration.

Exhibits.—Nearly 100 manufacturers of water works supplies will show their products in the large hall on the convention floor of the Royal York Hotel, and already this large room, 62 ft. by 164 ft., is unable to accommodate everyone who desires to be represented at this meeting.

The following is a list of the exhibitors who have been assigned space.

Pittsburgh Equitable Meter Company
The American City
Paradon Mfg. Company
U. S. Cast Iron Pipe and Foundry Co.
Buffalo Meter Company
National Tube Company
Public Works (Journal).
Neptune Meter Company
Thomson-Adriance, Inc.
Eddy Valve Company
National Water Main Cleaning Co.
The A. P. Smith Mfg. Company
Water Works Engineering
R. D. Wood & Company
The American Brass Company
Union Water Meter Company
Canadian Engineer
The Kennedy Valve Mfg. Co.
Gillette Publishing Company
McWane Cast Iron Pipe Company
The Dorr Company
Engineering News-Record
Mueller Company
Hays Manufacturing Company
W. J. Savage Company
Lock Joint Pipe Company
Michigan Valve and Foundry Co.
Chicago Bridge and Iron Works
National Meter Company
Builders Iron Foundry
Columbian Iron Works
Pittsburgh-Des Moines Steel Co.
Rensselaer Valve Company
Worthington Pump and Machinery Corp.
International Filter Company
Layne & Bowler, Inc.
Wailes Dove—Hermiston Corp.
Bingham & Taylor Corp.
Lead Lined Pipe Company
The James Morrison Brass Mfg. Co.
R. W. Sparling
The Pitometer Company
David B. McWilliams
Ross Valve Mfg. Co., Inc.
Fittings Limited
Canadian Brass Company, Ltd.
Ford Meter Box Company
Fairbanks, Morse & Company
The Leadite Company
Red Hed Mfg. Company
Francis Hankin & Co., Ltd.
Hersey Mfg. Company
Hydraulic Development Company
Empire Brass Mfg. Co., Ltd.
Simplex Valve & Meter Co.
Gamon Meter Company
Badger Meter Mfg. Company
Canada Iron Foundries, Ltd.
Iowa Valve Company
Automatic Cone Valve Company
Phoenix Meter Company
Wallace & Tiernan Co., Inc.
Barber-Greene Company
National Aluminate Corp.
The Central Foundry Company
East Jersey Pipe Company
Jenkins Bros. Limited
Gartshore Thompson Pipe & Foundry Co., Ltd.
Canadian Westinghouse Company, Ltd.
The American Rolling Mill Company
American Cast Iron Pipe Company
De Laval Steam Turbine Company
James B. Clow & Sons
National Iron Corporation, Ltd.
Jordan, Roberts Sales, Ltd.
The Canada Valve & Hydrant Co., Ltd.
Page-Hersey Tubes, Ltd.
T. McAvity & Sons, Ltd.
Canadian Industries, Ltd.
The Atlas Mineral Products Co.
Canada Metals Co., Ltd.
Chase Companies, Inc.

The program of the 49th annual convention follows:

MONDAY, JUNE 24, 1929

Forenoon

8:00 Registration.

9:00 Committee on Water Works Practice.

Malcolm Pirnie, Chairman. Hazen, Everett & Pirnie, Consulting Engineers, 25 W. 43rd St., New York, N. Y.

11:00 Executive Committee.

Afternoon Sessions

Plant Management and Operation Division and Superintendents' Round Table Discussion.

H. F. Huy, Chairman, General Manager, Western New York Water Company, 11 Niagara St., Buffalo, N. Y.

2:00 Ball Room.

The following members will lead the discussions:

J. W. Ackerman, Watertown, N. Y.
W. W. Brush, New York, N. Y.
C. K. Calvert, Indianapolis, Ind.
W. S. Cramer, Lexington, Ky.
F. C. Dugan, Louisville, Ky.
J. E. Gibson, Charleston, S. C.
D. E. Kepner, Denver, Colo.
M'Kean Maffitt, Wilmington, N. C.
W. S. Patton, Ashland, Ky.
A. U. Sanderson, Toronto, Ont., Can.
J. F. Skinner, Rochester, N. Y.
L. A. Smith, Madison, Wis.

2:00 West Hall.

Committee No. 1—Standard Methods of Water Analysis.

J. J. Hinman, Jr., Chairman, Associate Professor of Sanitation, University of Iowa, Iowa City, Ia. Everybody welcome.

Evening

9:00 Informal Reception and Dance. Concert Hall.

Address of Welcome—Mayor Samuel McBride of Toronto.

TUESDAY, JUNE 25, 1929

Forenoon Sessions

9:00 Ball Room.

Opening of Convention.

William W. Brush, President.

Announcement of Officers and Trustees elected for the year 1929-30.

Reports of Secretary, Treasurer and Executive Committee.

Action on Budget.

Report of Committee on Water Works Practice.

New Business.

Conference of Committee No. 19, Boiler Feed Water Studies.

Sheppard T. Powell, Chairman, Chemical Engineer, 213 St. Paul Pl., Baltimore, Md.

9:00 West Hall.

Recent Developments in Boiler Operation and Their Influence on Feedwater Treatment.

Sheppard T. Powell, Chemical Engineer, 213 St. Paul Pl., Baltimore, Md.

Deaeration of Boiler Feedwater.

J. R. McDermet, Research Engineer, Elliott Company, Jeannette, Pa.

The Dissociation of Water in Steel Tubes at High Temperatures and Pressures.

Illustrated by Lantern Slides.

C. H. Fellows, Detroit Edison Company, Detroit, Mich.

Calculation of Chemicals for Water Softening.

A. M. Buswell, Chief, State Water Survey, Urbana, Ill.

TUESDAY, JUNE 25, 1929

Afternoon Sessions

2:00 Ball Room.

Symposium on Pumping Station Practice:

Selection of Pumping Station Equipment.

Illustrated by Lantern Slides.

A. P. Pigman, American Water Works & Electric Company, New York, N. Y.

Equipment for Electrically Driven Pumping Stations.

R. L. Baldwin, Burns & McDonnell, Consulting Engineers, Kansas City, Mo.

Pump Discharge Headers and Pump Piping for Waterworks Stations.

Illustrated by Lantern Slides.

F. G. Cunningham, Fuller & McClintock, Consulting Engineers, 170 Broadway, New York, N. Y.

Discussion by L. A. Day, Water Commissioner, St. Louis, Mo.

Selection of Equipment for Clove Pumping Station of Staten Island System.

William Flannery, Mechanical Engineer, Department of Water Supply, Gas & Electricity, New York, N. Y.

Comparative Data on Steam and Electrical Pumping Stations.

Illustrated by Lantern Slides.

John F. Laboon, J. N. Chester Engineers, Pittsburgh, Pa.

Conference of Committee No. 19, Boiler Feed Water Studies.

2:00 West Hall.

The Prevention of Pitting in Locomotive Boilers by Exclusion of Dissolved Oxygen from the Feedwater.

C. H. Koyl, Engineer of Water Service, Chicago, Milwaukee, St. Paul & Pacific Railroad Company, Chicago, Ill.

Discussion by R. E. Coughlan, Supervisor of Water Supply, Chicago & Northwestern Ry. Co., Chicago, Ill., and F. N. Speller, National Tube Co., Pittsburgh, Pa.

Railway Water Treatment Progress and Research Requirements.

R. C. Bardwell, Superintendent Water Supply, Chesapeake & Ohio Railway Company, Richmond, Va.

Hydrogen Ion and Conductivity Measurement.

Illustrated by Lantern Slides.

C. Z. Rosecrans, Chief of Chemical Division, Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

2:00 For the Ladies—

Bus tour of city and tea at Royal Canadian Yacht Club—see page 12.

Evening

6:45 Dinner, Water Purification division.

8:00 Ladies' Card Party.

WEDNESDAY, JUNE 26, 1929

9:00 Ball Room.

Business Meeting Canadian Section.

10:00 Ball Room.

General Session—(This session will open one hour later than ordinarily to provide for the business meeting of the Canadian Section and obviate decreased attendance which would otherwise occur if the two meetings were held concurrently.)

Ethics for Engineering Services.

Nicholas S. Hill, Jr., Consulting Engineer, 112 East 19th St., New York, N. Y.

Durability of Distribution Systems.
Illustrated by Lantern Slides.
H. Y. Carson, National Cast Iron Pipe Company, Birmingham, Ala.
Operating Experiences with Large Capacity Filter Plants.
J. Clark Keith, Chief Engineer, Essex Border Utilities Commission, Windsor, Ont., Can.
Water Purification Division.
W. F. Langelier, Chairman, Associate Professor of Sanitary Engineering, University of California, Berkeley, Calif.
9:00 West Hall.
Values in Natural and Artificial Purification with Reference to the Sangamon River at Springfield, Ill.
Illustrated by Lantern Slides.
Charles H. Spaulding, Superintendent of Purification, Springfield, Ill.
The Deposition of Manganese Dioxide in the Aqueduct of the Catskill Water Supply.
Frank E. Hale, Director of Laboratories, Department of Water Supply, Gas and Electricity, New York, N. Y.
Micro-organisms in the Lake Michigan Water and Their Effect on Filtration.
Illustrated by Lantern Slides.
John R. Baylis and H. H. Gerstein, Bureau of Engineering, Chicago, Ill.
Innovations in the Treatment of Water in the Province of Ontario.
A. V. DeLaporte, Chemist, Department of Health of Ontario, Toronto, Ont., Can.
Some Unusual Features in Design of the New Water Purification Plant at Niagara Falls.
F. A. Dallyn, Civil Engineer, 71 Knight St., W., Toronto, Ont., Can.

WEDNESDAY, JUNE 26, 1929

Afternoon Session

2:00 Ball Room.
Field Practice in Chlorination of New and Old Water Mains.
Joseph S. Strohmeyer, Asst. Civil Engr., Water Department, Baltimore, Md.
The Chlorine Institute Standard Valve for Chlorine Containers.
Illustrated by Lantern Slides.
R. T. Baldwin, Secretary, The Chlorine Institute, New York, N. Y.
Cobble Mountain Dam of the Springfield, Mass., Water Works.
Illustrated by Lantern Slides.
Allen Hazen, Hazen, Everett & Pirnie, Consulting Engineers, 25 West 43rd St., New York, N. Y.
Water-Borne Epidemics on Ships with Reference to the Outbreak on the Lake Gaither.
I. W. Mendelsohn, U. S. Public Health Service, 45 Broadway, New York, N. Y.
Discussion by J. I. Connolly, Chief, Bureau of Sanitary Engineering, Chicago Department of Health, Chicago, Ill.; George H. Ferguson, Chief Engineer, Department of Pensions and National Health, Ottawa, Ont., Can., and Arthur E. Gorman, Wallace & Tiernan Co., Inc., Newark, N. J.
2:45 For the Ladies—
Shopping tour and tea.

Evening Session

8:00 Ball Room.
General Session—Preceding Smoker.
The Toronto Water Works System.
R. C. Harris, Commissioner of Works, Toronto, Ont., Can.
The New Filtration Plant and Other Extensions of the Toronto Water Works.
Illustrated by Lantern Slides.
William Gore, Consulting Engineer, Toronto, Ont., Can.
8:00 Ladies' Theatre Party.
9:30 Smoker. Concert Hall.

THURSDAY, JUNE 27, 1929

Forenoon Sessions

Plant Management and Operation Division.
H. F. Huy, Chairman, General, Western New York Water Company, 11 Niagara St., Buffalo, N. Y.
9:00 Ball Room.
Business Meeting of Division.
Pure Stream Movement Will Accomplish Its Purpose.
Scotland G. Highland, General Manager, Clarksburg Water Board, Clarksburg, W. Va.
Cement for Cast Iron Pipe Joints.
O. G. Goldman, Assistant Superintendent of City Distributing System, Spring Valley Water Company, San Francisco, Calif.
Management and Operation of a Canadian Water Works System.
W. E. MacDonald, City Water Works Engineer, Ottawa, Ont., Can. Discussion—J. Walter Ackerman, City Manager, Watertown, N. Y.; R. L. Dobbin, Superintendent Water Works, Peterborough, Ont., Can.; G. G. Routledge, Superintendent Water Distribution, Toronto, Ont., Can.
The Two-Main System of Water Distribution.
Illustrated by Lantern Slides.
J. B. Eddy, Engineer, Water Pipe Extensions, 404 City Hall, Chicago, Ill.
Water Purification Division.
9:00 West Hall.
The Relation of Direct B. Coli and B. Aerogenes Counts, Obtained on Cyanide-Citrate Agar, to Sources of Pollution.
Illustrated by Lantern Slides.
Fred O. Tonney and R. E. Noble, Bureau of Laboratories and Research, Department of Health, Chicago, Ill.
Lactose Fermenting Bacilli Growing on Leather Washers.
Frank E. Greer and Laura C. Kells, Bureau of Laboratories and Research, Department of Health, Chicago, Ill.
Ultra-Microscopic Studies of Colloids in Water.
C. H. Christman, National Aluminate Corporation, Chicago, Ill.
The Use of Activated Carbon in Removing Taste Producing Substances from Water.
Illustrated by Lantern Slides.
John R. Baylis, Physical Chemist, Bureau of Engineering, Chicago, Ill.

THURSDAY, JUNE 27, 1929

Afternoon Sessions

2:00 Ball Room.
General Session.
G. G. Dixon, Chairman, Deputy Chief Engineer, Mahoning Valley Sanitary District, Youngstown, O.
Symposium on Large Size Pipe Lines: Welded Steel Pipe at Springfield, Mass.
Illustrated by Lantern Slides.
Allen Hazen, Hazen, Everett & Pirnie, Consulting Engineers, 25 West 43rd St., New York, N. Y.
Electrically Welded Steel Pipe Lines.
Illustrated by Lantern Slides.
Samuel Martin, Jr., Industrial Engineer, General Electric Co., Schenectady, N. Y.
Discussion—William Flannery, Mechanical Engineer, Department of Water Supply, Gas and Electricity, New York; J. F. Lincoln, President, Lincoln Electric Co., Cleveland; E. E. Shanor, Petroleum Iron Works Co., Sharon; F. H. Stephenson, Engineer of Water System, Detroit.
Notes on European Pipe Practice.
R. H. Keays, Chief Engineer, Ulen & Company, Athens, Greece.
Standard Practice in Steel Plate Pipe Lines.
Discussion—Wm. W. Brush, F. G. Cunningham, John F. Laboon, A. V. Ruggles, F. H. Stephenson, T. H. Wiggin, F. E. Winsor, C. V. Witt.
Water Purification Division.
2:00 West Hall.
Trends in Municipal Zeolite Water Softening.
Illustrated by Lantern Slides.
W. J. Hughes, Mechanical Engineer, and H. B. Crane, Principal Assistant Engineer, International Filter Company, Chicago, Ill.
Reduction of Carbonate Hardness by Lime Softening to Theoretical Limit.
Charles P. Hoover, Chemist in Charge, Water Softening and Purification Works, Columbus, O., and James Montgomery, Superintendent of Water Works, Piqua, O.
Zeolite Softening Plant Operating Experiences.
Illustrated by Lantern Slides.
D. E. Davis and J. T. Campbell, J. N. Chester Engineers, Pittsburgh, Pa.
Operating Experiences with a New Water Softening Plant at Marion, O.
Illustrated by Lantern Slides.
Martin E. Flentje, Superintendent of Filtration, Community Water Service Company, 46 Cedar Street, New York, N. Y., and Charles Whysall, Chemist in Charge, Marion Water Softening Plant, Marion, O.

Evening

7:30 Dinner Dance—Informal. Concert Hall.

FRIDAY, JUNE 28, 1929

Forenoon Session

9:00 Ball Room.

New Developments in the Safeguarding of Cross Connections in New York State.

Illustrated by Lantern Slides.

C. A. Holmquist, Director, and Earle Devendorf, Associate Director, Division of Sanitation, State Department of Health, Albany, N. Y.

Mechanical Developments in Water Treatment Practice.

Illustrated by Lantern Slides and Motion Pictures.

C. T. Leander, The Dorr Company, Toronto, Ont., Can.

Steel Tanks for Water Works Systems.

Geo. T. Horton, President, Chicago Bridge & Iron Works, Chicago, Ill.

Methods of Water Softening and Filtration.

J. A. McGarigle, Permutit Company of Canada, Ltd., Toronto, Ont., Can.

Afternoon Sessions

2:00 Ball Room.

Joint Session Plant Management and Operation Division, and Superintendents' Round Table Discussion.

Effect of Rigid Jointing Material on the Strenth of Pipe Bells.

W. W. Brush, Chief Engineer, Department of Water Supply, Gas and Electricity, New York, N. Y.

Cement Lining Small Iron Pipe—A Method Suitable for Small Utilities.

Illustrated by Lantern Slides.

R. W. Reynolds, Superintendent, West Palm Beach Water Company, West Palm Beach, Fla.

2:00 Committee on Water Works Practice.

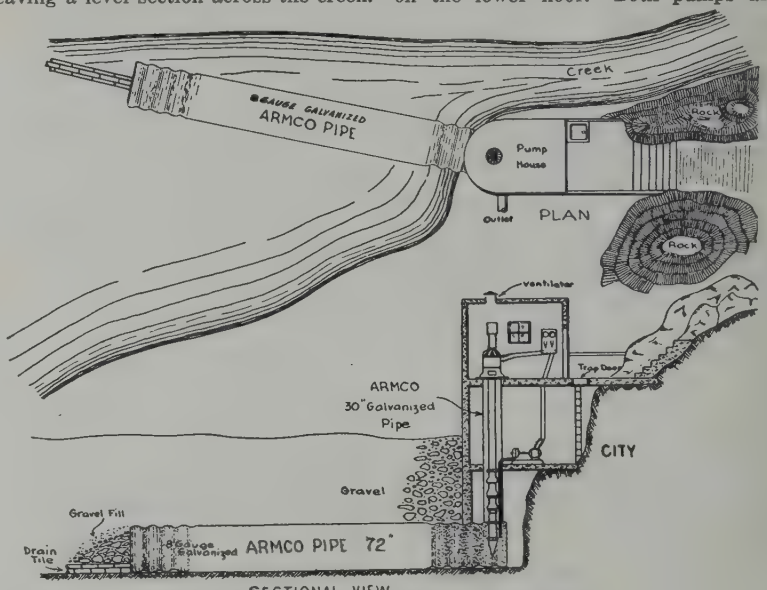
New Well Construction in Prescott

Perforated Corrugated Pipe Infiltration Gallery

By ARTHUR J. KLINE
City Engineer, Prescott, Ariz.

PRESCOTT, ARIZ., a mountain town of 8,000 population has probably as much trouble developing water as any town outside the desert. Fifty-four hundred feet in elevation, surrounded on three sides by mountains and on the fourth by a receding valley it is aptly called the Jewel of the Mountains. All the water passing this town must fall within six miles, and all is carried by Granite Creek running through town and down the valley.

A storage dam in the hills south of town impounds seven months storage and furnishes ample water during the years of normal rainfall, but when no snow nor rain falls for one year this reservoir is empty. Over a period of years by experimenting with cutoff walls, diversion dams, tunnels, side infiltration galleries and wells the water department has tried to use the under ground water of Granite Creek as an emergency supply. In 1928 a successful well was developed. At a narrow point across Granite Creek the gravel was stripped to bedrock with a drag line. The high points were shot off leaving a level section across the creek.



Plan and Section of New Well at Prescott, Ariz.

A 50-ft. section of 72-in. special collection pipe made of No. 8 gauge galvanized corrugated Armco ingot iron fitted with a 30-in. No. 10 gauge galvanized corrugated Armco ingot iron riser was installed. The collection pipe was perforated with ½-in. holes all around in the valley of every corrugation on five-inch centers. This equals 8 sq. ft. of opening. The ends were bulkheaded and from one was run three 6-in. drain tile laterals. The backfill over both tile and collecting pipe was made of 2 ft. of graded rock, then ordinary sand and gravel up to the level of the creek.

The Armco collection pipe was chosen instead of a cutoff wall for the accessibility of the tunnel. During low water when the pump holds the well low a man can decend a ladder in the pump house and walk back through the tunnel to clean out any sand or silt. The pipe has a long life and will apparently last indefinitely. When not pumping the water flows through the well and always shows fresh and clear. During the recent dry period the pump ran 2 hours and was off one hour. A flood 4 ft. deep came down the creek running muddy water from bank to bank. A man sent down to investigate reported that the pump was still running clear water and still shutting off one hour out of three, showing that the water filtered to bedrock some distance from the pump house.

After the first month of pumping the well was cleaned and since then no sand has come through the gravel bed.

A vertical 100 h.p. motor connected to the 600 g.p.m. turbine pump is on the upper floor. A multiple centrifugal pump of 300 g.p.m. capacity is direct connected to a horizontal motor on the lower floor. Both pumps are operated from the same automatic starter and float switch.

The whole layout has been very successful and considering the low cost of installation and lack of maintenance the work stands as good 1928 construction methods.

Street Traffic Survey for Kansas City, Mo.—A street traffic survey for Kansas City, Mo., was started on May 15 under the direction of Dr. Miller McClintock. It is expected the survey will be completed in a year. The estimated cost is $25,000. The survey, which will be city-wide in scope, is being made for the purpose of developing a comprehensive plan for relief from traffic congestion and traffic accidents.

Detroit Voters Defeat Subway Plan.—At a recent election the voters of Detroit rejected the proposal for a subway. The Rapid Transit Commission had recommended that 17 per cent of the total tax be raised by an ad valorem tax on the city at large; 51 per cent on benefited property adjacent to the subway, and 32 per cent to pay for train tracks and other equipment, through a ten-cent subway fare.

Methods of Financing Municipal Improvements

Different Types of Municipal Obligations Classified and Discussed

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WHENEVER a municipal improvement is to be constructed it usually involves the borrowing of money because the growing needs of municipalities have consumed revenues as rapidly as, and in many instances more rapidly than funds could be provided. Statutes authorizing the levy of taxes do not contemplate the accumulation of large surpluses which may be used for an improvement to be constructed at some future time. A thrifty community may be found that has carefully protected its treasury, and surpluses exist either by reason of savings in ordinary corporate expenses or profits from the operation of a water works or some other utility, but this is not the usual case. At times legislatures have authorized the levy of a special tax for a specified period for the purpose of constructing some particular improvement such as a courthouse or roads. This method of financing is not satisfactory because the funds come in over a period of years and it is not practical or economical to so extend construction work.

The federal government contributes a portion of the cost of some improvements, particularly road work and levee work, and when such contributions are made the government insists upon either supervision or actual construction of the improvement. In those instances the municipality is sometimes required to turn its money over to the government for expenditures. Experience has demonstrated that the tax payers get their full dollar of value where this procedure is followed.

It is impossible in an article of this type to go into any detail as to the particular procedure for municipal financing since that is governed by the statutory laws of various states, and any consideration of that subject would require a complete detailing of the statutory procedure prescribed by the several states.

In any consideration of municipal financing it is well to have clearly in mind the different types of municipal obligations. A classification of these bonds must group itself on the basis of taxes or revenues to pay the same, from the viewpoint of both the issuing municipality and the purchaser. The following classification and suggestions are submitted:

Unlimited Ad Valorem Tax Bonds.—Principal and interest of these bonds are payable from unlimited ad valorem taxes levied by constitutional mandate at the time the bonds are issued, or for the levy of which mandatory provisions exist, so that all that remains to be done is to extend and collect the tax. This is the best type of municipal bond and the only worry in connection with these bonds is as to the integrity of the community and the probability of its continuance with ample values to support the taxes.

Limited Ad Valorem Tax Bonds.—These bonds are exactly the same as the limited ad valorem tax bonds except that by constitutional or statutory enactment the amount which may be levied in any year to pay principal and interest is limited. In determining the value of these bonds special consideration must be given to the probable amount of taxes which may be realized over the lifetime of the issue from the limited levy, and also as to whether the statute permits the issuance of additional obligations against such tax which will share ratably in the proceeds thereof.

General Obligation Improvement Bonds.—The primary tax to pay these bonds consists of special assessments levied upon benefited property and the obligation requires the municipality to levy ad valorem taxes sufficient to make up deficiencies. This makes a very desirable bond provided the aggregate amount thereof is not disproportionate to the assessed value of taxable property of the municipality; for instance, if the assessed value of the municipality is $2,000,000 and the amount of such bonds outstanding is $2,000,000, patently the bonds are little better than a straight special assessment bond.

Revenue Bonds.—These obligations are payable from excise levies such as water rents, instead of ad valorem taxes, and are usually issued for the purpose of constructing water works or other utilities. Recently an endeavor has been made to add to this type of bond obligations payable from gas taxes and the like. The test applicable to these bonds is the certainty and sufficiency of revenues, together with statutory requirements tending to produce integrity in the application of the revenues and assurance that sinking fund requirements come before operating charges.

Benefit Tax Bonds.—These bonds are payable from taxes to be extended from year to year against benefited property, the aggregate amount of which benefits is fixed. This type of bond is usually issued by irrigation districts and some of the western drainage districts.

Special Assessment Bonds.—These are bonds payable from special assessments levied in a specified amount upon particular properties benefited from local improvement work. These bonds constitute desirable securities if the property values are sufficient to support the special assessment liens and the amount of assessments available to pay the bonds is ample to retire the issue.

Tax Bills.—These obligations are issued by the municipality against particular pieces of property on account of benefits derived from the construction of a local improvement. They are in odd amounts and are a lien only upon particular pieces of property. Of course the value of each depends upon the value of the property against which it is issued. The great objection to this type of security is its marketability. The most successful mode of handling this type of paper has been to deposit the tax bills with a trust company and issue debentures or participating certificates against the proceeds of the aggregate deposit.

Bonds Payable from Taxes to Be Levied.—This type of bond is rapidly disappearing. Its weakness is the possibility that the local officials will fail to levy the necessary taxes in a particular year. This weakness is more theoretical than real. The good faith of the community usually prompts the performance of the necessary acts. Many government obligations are subject to this criticism.

Temporary Borrowing.—These obligations are issued in anticipation of permanent financing or in anticipation of the collection of ordinary annual operating taxes.

General Discussion

Ad valorem taxes are levied upon the basis of value against all of the taxable property in the municipality.

Benefit taxes or special assessments are enforced contributions from land owners for enhancement of value received by particular properties on account of the construction of a local improvement; for example, a pavement in front of property increases the market value of that property and the benefit tax is levied on account of this increase.

Excise taxes are levies made upon commodities and from an entirely distinct basis of taxation from either of the two foregoing methods. The most

Editors Note: The author of this article specializes in municipal bond law.

conspicuous in this class of taxes so far as municipal bonds are concerned at the present time are water and other utility revenues. There is a growing tendency to issue bonds in anticipation of the collection of these revenues. It is probably safe to anticipate that this type of revenue is as certain as property value. The consumption of water in a given community is probably dependent upon practically identically the same elements as those which produce value to property, to wit, population and industry. Whether gasoline taxes, license fees and the like are sufficiently stable to warrant their anticipation by long-time obligations may be open to some argument.

Improvements may be constructed by the use of more than one type of financing. Some municipalities may construct a water works improvement by the use of ad valorem tax bonds which constitute an unlimited obligation of the entire municipality, by the use of special assessments levied upon benefited property, or by revenue bonds which will be payable only out of revenues to be derived from the completed improvement. Which of these methods should be used is for the determination of the corporate authorities. The factors which should influence their decision are the cheapest net cost of the improvement and the conservation of the debt incurring power of the municipality for other needed improvements which must be paid for by the full faith and credit obligations of the municipality.

A particular type of security in a given state may be in bad repute due to defects in the law authorizing the issuance or otherwise. As far as possible municipalities should avoid the use of any type of security which is thus depreciated. It is always desirable to issue the most marketable type of security in order that the best price may be obtainable therefor and the net cost of the improvement reduced.

A particular improvement may be constructed by a contractor who will take in payment bonds issued therefor, but if it is patent that a small percentage of the par value of bonds actually goes into the construction of the improvement, then it is most unwise to proceed. There is no way to establish an arbitrary percentage of the par value of obligations which should represent cost of labor, material and reasonable contractor's profits, but certainly if less than 75 per cent of the par value of the bonds actually goes into labor, material and reasonable contractor's profits, the municipality should seriously consider deferring the construction of that improvement.

Factors Affecting Value of Bonds.—The value of municipal bonds and the reputation of the issuing municipality would be aided if the corporate authorities seriously considered the necessity of a contemplated improvement and ordered its construction only when it is patent that the improvement is necessary and that the type and design selected are adequate for the needs but are not extravagant. Certainly the construction of a schoolhouse, city hall or any other improvement far in excess of needs, either as to size or elaborateness, affects the price which may be obtained for that issue, and may ultimately affect the credit of the municipality. It also imposes an unreasonable burden upon the tax payers. To avoid these excesses many states have imposed limits upon the amount of indebtedness which the municipality may incur.

Other important factors in the value of municipal bonds are the time and manner of payment. There is a well developed tendency to so arrange the maturities of the bonds that the issue will be fully paid before the usefulness of the improvement is exhausted, and to make the principal payable in instalments over a period of years. This requires the tax payers using the improvement to pay for it and avoids the necessity of accumulating sinking funds.

The experience with sinking funds has not been entirely satisfactory. Sometimes the sinking fund is misappropriated or lost, and sometimes it is not even collected. If it is collected it is impossible to invest the sinking fund in desirable securities which will produce interest at as large a rate as that being paid on outstanding bonds; consequently it is preferable to so arrange the maturities of the bonds that the amount of taxes paid annually on account of said bonds will be about the same each year.

In conclusion it is submitted that in the financing of any municipal improvement effort should be made to issue that type of obligation which will provide the cheapest financing, constitute a reasonable tax burden and not embarrass the municipality in its ordinary operations or in its future developments and will be fully paid within the lifetime of the improvement.

Care should be taken to see that all proper safeguards are provided in the law authorizing the issuance so as to encourage purchasers and thus give a broader market for the securities. These safeguards must consist of two elements: (1) Provisions encouraging and enforcing integrity of municipal officials in the administration of the funds and the prompt collection and application of taxes for the payment of obligations, and (2) The most liberal requirements with respect to the amount and certainty of collection of taxes sufficient to pay maturing principal and interest. As to the value of a particular security, the reputation of the issuing body, its population, value and relationship between indebtedness and value and limitations affecting the amount of indebtedness must all be considered.

Methods of Financing Constantly Changing.—It must be remembered that modes of financing are continually changing. Municipalities should readily avail of all new and improved methods of financing which will add value; for instance, where there are overlapping taxing districts a coordination of their financing will prevent overloading the market and thus increase the sale value of their securities. When it becomes advantageous to finance a particular type of improvement such as road construction from the sale of securities payable from gas taxes and license fees, that method should be adopted, particularly in those communities where the burden of taxation to pay general obligation bonds affects land values.

A contractor or municipal official would do well to employ competent counsel to explain fully the operation of any existing law under which it is proposed to construct an improvement so that he may know exactly where he stands before contracts are made.

Municipal Golf Courses in New York State

According to the City Record, the official publication of the city of Boston, Mass., five cities in New York State operate municipal golf courses. New York City has six courses; Buffalo has four; Rochester has three; Syracuse has two, and Niagara Falls one. Ten of these sixteen courses have eighteen holes and six have nine holes. The sizes of the eighteen-hole courses range from 72 to 305 acres, and for the nine-hole courses from 30 to 79 acres. The 1927 cost of maintaining the six courses in New York City was approximately $100,000; the revenues from fees, lockers and concessions for the golf season was about $212,000. The cost of maintaining the three courses in Buffalo for 1927 was $45,000 and the revenues $30,000; in Rochester the three courses cost $19,690 to maintain and produced a revenue of $39,126; the two courses in Syracuse cost $3,631, with a revenue of $10,375; and the cost of maintaining the course in Niagara Falls was $15,000, with a revenue of $13,000. The number of persons using the New York City links was about 272,000; the Buffalo links, 30,000; the Rochester links, 118,890; and the Niagara Falls links, 29,375.

The fees charged for use of links in New York City were $10 a season or $1 a day; in Buffalo 50 ct. per round on three of the courses, and $25 a year, or 50 ct. a round, on the other course; in Rochester $7.50 a season or $1 per day; in Syracuse 35 ct. on week days, 50 ct. on Sundays and holidays; in Niagara Falls $10 a season or 50 ct. a day. In New York City a locker charge of $10 to $20 is made, and in Buffalo a charge $5 per year for lockers. All these cities have clubhouses, except Niagara Falls, and New York, Buffalo and Syracuse have showers.

Natural Basins Flooded to Increase Flow of Supply Wells

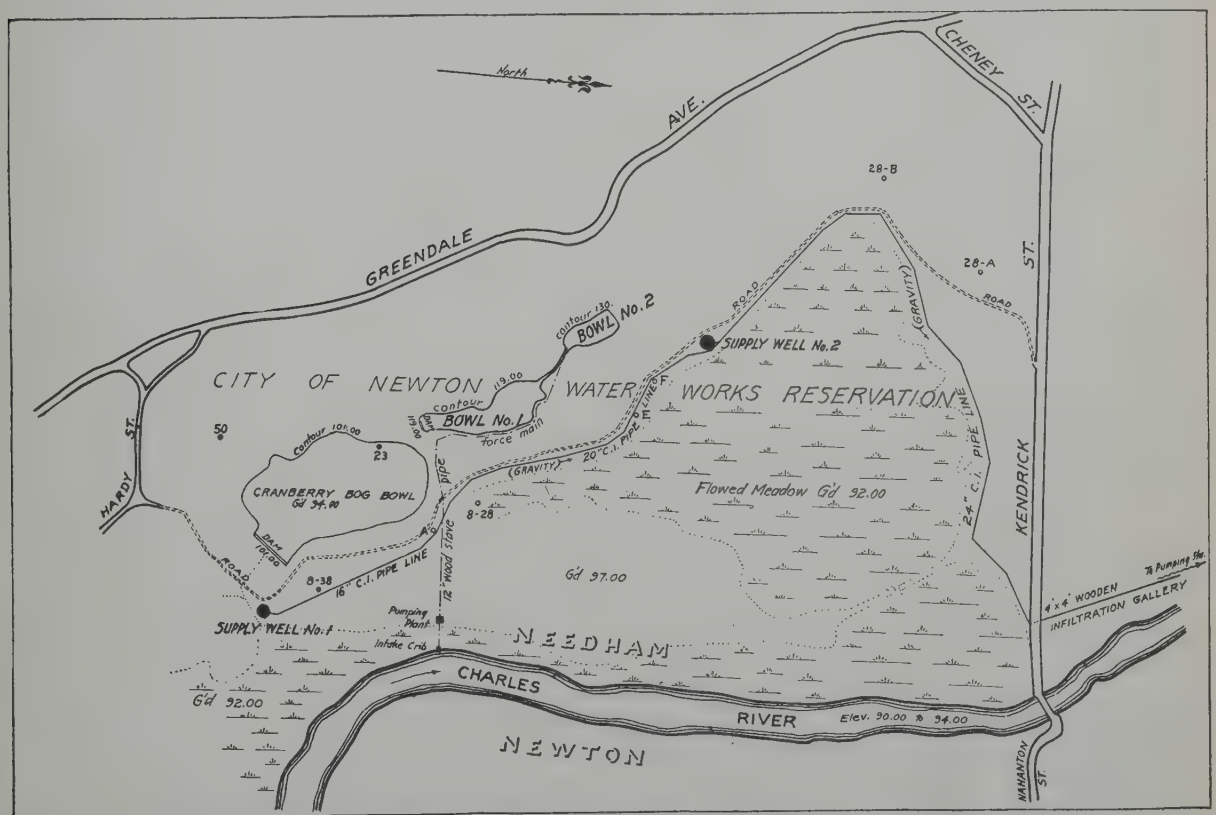
Newton, Mass., Adds to Water Supply by Ingenious Method

DURING the year 1928 the city of Newton, Mass., was confronted with the problem of securing an additional water supply. The water supply of the city is obtained largely from two large concrete supply wells situated in the meadows on the westerly side of the Charles River. These wells intercept the ground water which flows from the higher lands to the west toward the lower levels of the Charles River valley and deliver it to the city mains. The presence of certain natural bowls or basins in the higher land just west of the wells suggested the possibility of increasing the flow of the wells by flooding the basins with water from the Charles River.

Natural Reservoirs Suggested.—Many borings and excavations conducted in the area occupied by the basins indicated that the underlying strata were composed of gravel and sand of such a texture as to furnish ready communication between the surface and the levels reached by the wells. This conclusion was confirmed by the rapidity with which surface water in the basins was observed to drain away into the ground. Thus it was anticipated that the scheme of filling the bowls with river water would be successful. The expense would not be great, as it would be necessary only to locate the basins to be used far enough from the wells to assure proper filtration and to remove surface materials and the top layers of soil. It was thought also that the quality of the supply pumped from the wells would be improved by the addition of the soft river water to the somewhat harder ground water. Again, it was considered that the action of air and sunlight upon the stored water would aid considerably in its purification. The additional storage capacity secured would not be limited to the volume of the basins flooded, but would consist also of the very appreciable capacity of the ground beneath the bowls.

Scheme Applied on Experimental Scale.—The accompanying map of the Newton water-works reservation shows the layout of river, wells and natural basins. It was decided to experiment first with the basin known as Bowl No. 1. This bowl is situated about 1,200 ft. back from the Charles River. The underlying strata of sand and gravel were covered with a layer of loam varying in depth from 2 to 5 ft., and it was first necessary to strip this soil. Accordingly an area 40 ft. wide and 700 ft. long in the bottom of the bowl was uncovered. The material was removed by a steam shovel and cast to the side of the trench so that it might be removed later if it was decided to carry the work beyond the experimental stage. This work, which involved the handling of 5,000 cu. yd. of material, was done for a contract price of $1,000.

A pump well was installed at the river and a line of 12-in. wood stave pipe was laid to the bowl. Pumping equipment consisted of an 8-in. centrifugal pump driven by a 20-hp. motor



Needham Water Works Reservation, City of Newton, Mass., Showing the Two Supply Wells, the Two Bowls and the Supply Line Leading from the Charles River

and capable of pumping approximately 1,400,000 gal. per day against a head of 50 ft. The pipe line, which had a total length of 950 ft., was laid at a total cost for labor and materials of about $2 per ft.

Flow Increased Appreciably.—Pumping of the river water was begun on Feb. 16 and, beginning with this date, the daily output of each of the supply wells was carefully measured. In addition, numerous tube wells were observed to determine the effect of flooding the bowl upon the level of the ground water. On Feb. 18 an increase in the flow of the supply wells was noticed, and it was observed that the ground water had begun to rise in the tube wells. The normal output of Well No. 1, as determined before the experimental flooding of the bowl, was about 800,000 gal. per day. The output of Well No. 2 was about 1,160,000 gal. per day. After ten days of pumping water into the bowl, an increase of 230,000 gal. per day in the output of Well No. 1 was noted, while the increase shown by Well No. 2 was about 550,000 gal. per day. Thus the total increase in the supply furnished by the two wells was about 40 per cent. During this period, the rate of flow into the bowl was 1,400,000 gal. per day. The increase of 780,000 gal. per day in the flow of the two wells gives a recovery of water pumped of about 56 per cent. Analyses of samples of the water showed a satisfactory quality. The experiment was deemed successful, and preparations were made to continue with the excavation and flooding.

Second Basin Stripped.—Excavation of the remainder of Bowl No. 1 was begun in July and completed in the fall. This bowl has a capacity of 6,000,000 gal. when filled to El. 119, and at this level the water covers an area of about 1.8 acres. Bowl No. 2, excavated at the same time, is much smaller, having a capacity of about 1,500,000 gal. when filled to El. 130. The area covered at this elevation of water is about 0.65 acres. Comparison of the added daily flow of the wells with the capacity of the bowls gives an idea of the rapidity with which the water drains away through the porous strata below the surface. About 14,500 cu. yd. of surface material were stripped from the two bowls at a cost of $9,500.

The total length of wood stave pipe line supplying the two bowls is now 1,730 ft. A concrete intake crib is being constructed at the river. A 24-in. vitrified pipe line leads to a pump well situated about 150 ft. back from the river bank. New pumping equipment consists of a 10-in. centrifugal pump, driven by a 50-hp. motor. This pump can deliver 3,500,000 gal. per day against a head of 60 ft.

Observations at the tube well marked 8-28 on the map showed that a large portion of the water not recovered by the two supply wells came to the surface in this vicinity, indicating that this would be a favorable site for a third supply well.

Contracts for stripping the bowls were executed by the John MacDonald Construction Co. The pipe line and pumping equipment were installed by the city water department. E. H. Harvey, designing engineer with the engineering department of the city, was in charge of the work. George A. Sampson, of Western & Sampson, Boston, Mass., is consulting engineer. W. P. Morse is city engineer of Newton.

Soft Water in the Dakota Sandstone

The geologic formation known as the Dakota sandstone, which underlies most of South Dakota and large parts of several other states, is well known for the thousands of flowing wells which it supplies and for the great artesian pressure that was formerly exerted on the water in these wells. The strongest well originally had pressures ranging from 100 to more than 200 lb. to the square inch and would throw up jets of water to heights of 100 ft. or more. Many of the wells that tap this sandstone are still flowing but with greatly reduced pressure, and some have ceased to flow.

Hard and Soft Water in Same Sandstone.—The Dakota sandstone is remarkable not only for the artesian pressure of its water but also for the variety of water that it contains, some of the water being very hard and some very soft. As a rule the upper strata contain soft water, and the lower strata contain hard water. In some places, as at Canton, South Dakota, and in large parts of western Minnesota, the Dakota sandstone rests on the irregular ancient land surface of hard pre-Cambrian rocks such as quartzite or granite. In some of these places the lower part of the formation is absent, and only the upper soft-water strata are encountered in drilling.

The hard water is generally very hard and otherwise highly mineralized, so that it is very unsatisfactory for washing or for use in steam boilers. Much of it is also unsatisfactory for drinking and cooking, but it is generally used for irrigating lawns and gardens. Some of the soft water is of good quality, being not only excellent for washing but also satisfactory for drinking and cooking, use in steam boilers, and irrigation. Much of the soft water, however, contains so much common salt and soda that it is disagreeable to the taste and deadly to vegetation and causes foaming when used in steam boilers. All of the water, both hard and soft, is considered especially desirable for live-stock supplies. The dissolved salts are apparently not unwholesome to the domestic animals, and the relatively high temperature of the water, which comes from great depths, makes it especially attractive and beneficial to them during the long cold winters.

Soft Water for Tub Night and Wash Day; Hard Water Rest of Week.—Some interesting local problems are created by this variety in the quality of the water. For example, at Ellendale, N. D., both hard and soft water were formerly supplied by the city waterworks. From Saturday night to Monday night the smaller supply of soft but rather salty water from the upper part of the Dakota sandstone was pumped into the system to furnish water for toilet and laundry uses, but later in the week the hard water from the deepest well was pumped into the system and was used for sprinkling lawns and irrigating gardens.

The experience at Canton, S. D., affords an example of a somewhat different problem. Here adequate quantities of hard water have for many years been pumped from shallow dug wells in gravel deposits for the city supply and the Government asylum. It was known, however, that soft water, satisfactory for every use, occurs in the Dakota sandstone at a depth of about 300 ft., and wells were drilled to recover this desirable supply. Unfortunately, the sandstone at this place, as in many other localities, is so fine grained and incoherent that the wells give trouble when they are heavily pumped, and it is difficult to recover large supplies.

Water Supply Problems Studied by Government.—The problems of the Dakota sandstone and of other water-bearing formations in the region in which it exists have been given much study by the Geological Survey of the United States Department of the Interior as to the quality of the water, decline of artesian pressure, methods of preventing waste, and methods of finishing wells so as to obtain large supplies without pumping sand. Recently a study was made of the problems at Canton, South Dakota, especially in regard to the Government water supply, and a brief report (Water-Supply Paper 597-C), prepared by O. E. Meinzer, has been published in which the studies at Canton are applied to the general problems of the Dakota sandstone. The report presents data as to the occurrence of soft water in an area where its existence has not until recently been known and calls attention to the possibilities of finding it in other localities in this general region in which at present only hard water is obtained. It presents, almost for the first time in hydrologic literature, detailed information as to the performance of wells in a sand whose physical and hydrologic properties were determined in the laboratory. It was prepared especially for the information of the water-well drillers of the Northwest in improving the water supplies of that region. The author considers the drillers his colaborers, for they have contributed generously to this and other investigations.

Court Decisions on Sanitary Matters

Recent Rulings of State Courts

MUNICIPALITIES Held Liable for Nuisance Caused by Sewer and Sewage Disposal Plant.—(New Jersey Court of Errors and Appeals; Ennever et ux. v. Borough of Bergenfield et al., 144 A. 809; decided Feb. 14, 1929.) An action was brought against certain municipal corporations to recover damages for injuries to plaintiff's property, resulting from the construction and operation by the defendants of a joint sewage-disposal plant and a joint sewage system. A jury found that the disposal by the municipalities of sewage into a small stream which flowed through plaintiff's land created a nuisance, and returned a verdict for the plaintiffs. The court of errors and appeals affirmed the judgment of the lower court, basing the liability of the defendants on the fact that, although they "were performing a public duty in constructing and operating the sewers and the disposal plant," they "were committing an active wrong, thereby causing special damage to the plaintiff's property."—Public Health News, April 26, 1929.

Construction of Statute Concerning Disposal of Dead Animals.—(Iowa Supreme Court; State v. Redlinger, 224 N. W. 83; decided March 12, 1929.) Section 2761, Code 1924, provided as follows:

> No person caring for or owning any animal that has died shall allow the carcass to lie about his premises. Such carcass shall be disposed of within 24 hours after death * * *.

By section 2762 a violation of the above section was made punishable by fine or imprisonment.

In a prosecution under the statute the defendant argued that the indictment charged more than one offense. In passing on this claim the supreme court had the following to say regarding its interpretation of the enactment:

> * * * Plainly the law is violated when the person caring for "any animal that has died" allows "the carcass to lie about his premises" for 24 hours without disposing of it as required. Thereby such person subjects himself to the penalty prescribed by section 2762. At the end of the 24 hours the offense is complete. * * * It was not intended to inflict a penalty for permitting a dead animal to remain uncared for for an hour or 10 hours but for 24 hours. * * *—Public Health News, May 3, 1929.

Authority of State Department of Health Sustained in Stream Pollution Case.—Authority of the Ohio State Department of Health to prevent stream pollution by order to a municipality that it cease the discharge of sewage into a stream was sustained by the full bench of the Ohio Supreme Court in a decision handed down April 24, 1929, in a case brought against the Department by the city of Bucyrus. The opinion was written by Judge Robinson.

This is a case (City of Bucyrus vs. Department of Health) wherein the city of Bucyrus contested the authority of the Department of Health to issue an order requiring the city to cease the pollution of the Sandusky river by the discharge of sewage into that stream. The order of the Department of Health was made Dec. 14, 1928, and this action was filed in the Supreme Court within the time limit fixed by statute. The petition of the plaintiff set forth many points on which error was claimed in the proceedings of the Director of Health and the Public Health Council, including the following:

> That as no complaint in compliance with Sec. 1249 G. C. had been filed with or presented to the Department of Health, the Director was without right or authority to make his finding.
>
> That sufficient evidence was not presented to sustain the finding and its approval, and the determination of the Public Health Council that the city be required to make certain changes and improvements; but that they were contrary to law, unlawful and unreasonable.
>
> That there was not sufficient evidence to sustain the order of the Director and its approval, and that they were unlawful and unreasonable.
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> That there was error by the Council in proceeding over the protest of the city of Bucyrus; that it acted without sufficient evidence before it; that it considered matters outside the record, and that it refused to require proof as to sufficiency of the complaint on which the Director acted.
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> That the sections of the Code under which the Director acted are unconstitutional, null and void, as being in conflict with the constitutions of both State and Nation.
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> That the act of the General Assembly, passed April 7, 1908, entitled "An Act to authorize the State Board of Health to require the purification of sewerage and public water supplies and to protect the streams against pollution," with its amendments, so far as it relates to matters other than public water supplies, is not an enactment to protect the public health; is not an exercise of the police power of the State, and confers no jurisdiction on the Department of Health in this proceeding.
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> That all the acts and orders of the Department of Health, the Director of Health and Public Health Council were made in violation of evidence, in an ex parte, summary and arbitrary manner, apparently under the influence of passion and prejudice, and therefore were unlawful and unreasonable.
>
> That due process of law was denied the plaintiff in error.

All these objections were brushed aside in the decision of the Court, which declared in specific terms that the so-called "Home Rule" amendment to the Constitution in no way curtails the sovereignty to the State over Municipalities in respect to sanitation for the promotion or preservation of the public health. The approved syllabus of the decision of the Supreme Court is as follows:

1—The provisions of Article XVIII of the Constitution of Ohio do not deprive the State of any sovereignty over municipalities in respect to sanitation for the promotion or preservation of the public health which it elects to exercise by general laws.

2—The holdings of this Court in the case of State Board of Health v. Greenville (86 Ohio St., 1), are as applicable to municipalities since the adoption of Article XVIII as they were before the adoption of that Article, and will be adhered to.

3—The report of an investigation required by Section 1249, General Code, is competent evidence at a hearing provided for in Section 1250, General Code, but is not conclusive, and the persons securing the data are subject to cross-examination and impeachment.

Opinion written by Judge Robinson, and concurred in by Marshall, C. J. Kinkade, Jones Matthias, Day and Allen, JJ.

On the same day the Supreme Court overruled the demurrer of the city of Delphos to a petition by the Department of Health for a writ mandamus to compel that city to comply with an order of the Department requiring the city to make certain changes and improvements in its methods of handling sewage, for the prevention of stream pollution. Grounds of the demurrer by the counsel for the city of Delphos were substantially the same as the basis of argument by counsel for the city of Bucyrus.—Ohio Health News, May 1, 1929.

Keeping of Swine and Dumping or Leaving Garbage in Town Restrained. — (Massachusetts Supreme Judicial Court; Inhabitants of Swansea v. Pivo, 164 N. E. 390; decided January 5, 1929.) The board of health of the town of Swansea adopted the following regulations:

> No person, firm or corporation shall keep or maintain within the limits of the town six or more swine over 3 months of age without a permit from the board of health.
>
> No person, firm or corporation shall deposit, dump or leave within the limits of the town any swill or garbage without a permit from the board of health and in such case in no place other than that fixed by the board and described in such permit. * * *

Thereafter the defendant kept a large number of swine in the town without a permit from the board of health and in violation of the regulations. The board of health, acting under statutory authority, then directed the issuance of an order of prohibition against the defendant, having already determined that the keeping of swine and the dumping or leaving of garbage by the defendant was dangerous to the public health and a nuisance. The defendant failed to obey the order and suit was brought by the town to restrain him. A decree, entered in favor of the town, was affirmed by the supreme court. Points determined by the appellate court are set forth in the quotations from the opinion, which follow:

> The [master's] report discloses, it was admitted by the plaintiff, that the records of the meeting held on July 8, 1927, when the regulations were adopted, and the records of the meeting of November 21, 1927, when the order of prohibition was voted, were amended by the clerk of the board of health the latter part of November or the first part of December, 1927, and that the amended records were signed by the clerk of the board. The master further found that "the amended records, * * * in evidence, are a true record of what took place at the meetings named." The records as amended plainly show that the regulations and order of prohibition were duly adopted. The clerk had power to amend his original records to conform to the truth. The amendments thus made became a part of the record and the whole record is to be considered as such. * * *
>
> The town may maintain a suit in equity to enforce regulations adopted by its board of health, under the provisions of G. L. c. 111, sections 31, 122, 143; * * * As the original

records were inaccurate and defective, it was within the power and was the duty of the clerk to amend them. It could be shown by a member of the board that the amended records were accurate. * * *

The defendant made an offer to prove that the board of health acted in bad faith in issuing the order of prohibition, and offered to show that the acts complained of did not constitute a nuisance and were not injurious to health. This evidence was rightly excluded. The proffered proof is not admissible in these proceedings. * * *

"The determination of the board of health is not a merely ministerial act; but is quasi judicial, in the sense that it is not to be contested or revised, except in the manner provided in the statute. * * *"

* * * It does not appear that any special authorization to continue the trade or employment pending this suit was given under G. L. c. 111, sec. 148.—Public Health News, March 15, 1929.

Sprinkler System for Curing Concrete Pavements

The accompanying photographs illustrate the scheme employed by W. F. Pigg & Son, Inc., contractors, Denver, Col., for curing concrete on their city paving jobs. By the adoption of this system, concrete curing costs are stated to have been cut to less than one-half the cost of puddling or sprinkling with hoses.

A 2-in. pipe line is placed down the center of the pavement, where the width is 25 ft. or less. For greater widths, two or more lines are used. Sprinkler heads are installed approximately every 20 ft. Where a fire hydrant is available, the pipe line is connected to the plug; in a section where there are no hydrants, it is necessary to use a force pump. With one fire hydrant working at a pressure of approximately 60 lb. per sq. in., it is possible to cure a section 25 ft. wide and approximately 1,000 ft. long. For larger areas, more plugs may be connected in. The sprinklers are operated only intermittently, the water being turned on for a period of about one minute every 10 to 15 minutes. The sprinkling period is, of course, variable —more water being required on hot days and less on cloudy days.

Consumption of water and the cost of labor are both much less where this method is used in preference to covering the pavement with moist earth or building earth dikes and flooding the surface, the contractors state. A boy, or a laborer paid a small wage, can handle an enormous section of finished pavement.

A patent on this method of curing pavements is pending.

One of the Sprinkler Heads

Curing a Concrete Pavement by Sprinkling

Monterey's Municipal Rose Garden

By FRANCIS E. LESTER

President, Monterey Chamber of Commerce

The municipal rose garden in Monterey, Calif., is just now in its fullest glory. More than 1,200 rose bushes are in bloom and the planting plan, which produces the maximum of mass color effects, displays these blooming bushes to the greatest advantage.

Visitors are found in the garden daily from many remote points; during a recent week, visitors to the garden included groups from Seattle, San Diego and Denver.

The garden was started by the city of Monterey a year ago, when a small part of the planting was done; but most of the roses have been planted this spring. The garden contains about 1,400 roses—more than 200 varieties of bush roses, over 60 varieties of climbing roses, 20 varieties of pillar roses and about an equal variety of standard or tree roses. Some of these latter are budded with three harmonizing colors on the stem.

A lily pool is in the center of the garden, ringed around by tree and baby roses. Surrounding this central feature are the mass plantings of red, pink, yellow, and new-bud roses. One beautiful bed contains fifty of the new single Vesuvius rose, a deep flaming scarlet, which is now in full bloom.

A unique feature of Monterey's municipal rose garden is that it is within two blocks of the business center of the town. It adjoins historic Colton Hall, first state capitol of California, and on all sides of the garden the visitor encounters historic landmarks such as the residence of General Fremont in 1847; the residence of Governor Alvarado; the "House of the Four Winds," and the former home of Thomas Larkin, first American consul.

In one of the most interesting spots in the garden is the planting, in adjoining beds, of the old and the new roses. Among the old roses are found examples of many roses no longer in commerce, originations of centuries ago, such as the York and Lancaster, the old Blush and several varieties of the Old Norse Roses. Oldest of all, and perhaps most interesting, are the two bushes of what is known as the Ancient Rose—identically the same rose that grew in the days of Greece and Rome. Immediately across the walk are examples of the very latest and finest roses, thus illustrating what the rose hybridist has accomplished in the development of the present-day rose of such exquisite form and marvelous coloring. In one corner of the garden are found plants of the species of parent roses, from which all hybrid roses have been created. Another corner is planted with the sweetbriers; another with the Austrian briers which gave to the hybridist the yellow tones found in the modern rose.

In one corner is a rose found in no other municipal rose garden in the world—the Father Junipero Serra Rose, created by Rev. Father Schoener of Santa Barbara and presented to Monterey's Municipal Rose Garden. There are many other interesting features of the garden to be found by the visitor.

Everything in the Monterey municipal rose garden is plainly marked with the name and date of origin. The beds are so arranged that every rose is easily seen from an adjoining walk or pathway.

The main approach to the garden is underneath a series of twelve arches, each arch planted with two similar climbing roses. Among these are found examples of the old roses of Monterey, including the famous Sherman Rose and other old roses no longer in commerce.

The financing of the garden and its perpetual maintenance are provided for by the city government, and the great number of people who have visited it in the past few weeks is a striking indication of their appreciation of the vision and foresight of the city authorities in providing for Monterey this, its chief beauty spot.

Taxes Paid Through Banks.—A new tax collection plan is now in force at Baltimore, Md., which allows payment of taxes through neighborhood banks.

Design of Sprinkling Filter Distribution Systems

A System for Calculating Pipe Sizes

By ANSELMO F. DAPPERT and W. H. WISELY
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FOR convenience in checking plans and to simplify the process of calculating pipe sizes for the distribution system which ordinarily involves laborious trial and error methods, we have developed a system which we believe to be positive and which eliminates most of the usual required assumptions.

In the formulas which we have developed there is only one item for which we need to apologize and that is the assumption that the friction coefficient for the same diameter pipe and the velocities which ordinarily prevail in a distribution system, are constant. This assumption is not quite true but from several detailed calculations we have shown it to be satisfactory for all practical purposes.

Under the usual assumption that there is no variation in the quantity of liquid supplied to the various nozzles and laterals, the loss due to entrance into any lateral or nozzle riser is the same as for any other lateral or nozzle riser. This being accepted, the maximum loss of head will occur in the nozzle farthest removed from the dosing tank. To be on the safe side it is customary to provide that the total loss of head calculated from the farthest removed nozzle to the dosing tank shall not be more than the total loss allotted to the distribution system.

The actual total loss in a distribution system can therefore be laboriously determined by calculating the frictional losses in each section of the lateral between nozzles, in each section of the main between laterals, in the section of main between the filter bed and siphon, the entrance losses into one lateral and one nozzle riser, and taking their sum. The losses through reducers are negligible.

In a main or lateral of uniform diameter, there is a certain equivalent quantity which if flowing throughout the entire length of main or lateral will produce a frictional loss of head equal to the sum of the actual frictional losses in each section of the main between laterals or in each section of a lateral between nozzles. The same is true for any section of a compound main or lateral. The problem therefore, is to determine the above equivalent quantity.

Two General Cases.—There are two general cases as follows:

(A) A main with two-way laterals. (Note that we designate a lateral as any pipe which supports nozzles and projects laterally from the main.)

(B) A main with one-way laterals or a lateral supporting a single row of nozzles.

Without going into the derivation of our formulas but with the statement that we can furnish any one interested in the subject with the proof we will state that

$$(1)\quad X = \frac{2\,(2^2+4^2+6^2\ldots+N^2)}{N}$$

(For main with two-way laterals.)

$$(2)\quad Y = \frac{1^2+2^2+3^2\ldots.+N^2}{N}$$

(For main with one-way laterals, or a lateral.)

where X = the number by which the discharge for one lateral should be multiplied to ascertain the equivalent quantity flowing in a main with two-way laterals.

Y = the number by which the discharge for one lateral (or one nozzle as the case may be), should be multiplied to ascertain the equivalent quantity flowing in a main with one way laterals, (or in a lateral, as the case may be).

N = the number of laterals (or in Equation 2, the number of laterals or the number of nozzles as the case may be).

In a compound main serving 2-way laterals, equivalent quantities flowing must be determined for each separate section of the compound main. Where x_1 x_2 etc. = the number by which the discharge for one lateral should be multiplied to ascertain this equivalent quantity flowing in the largest, next to the largest, etc. section of the main, and N_1, N_2, N_3, etc. = the total number of laterals in the bed, the total number of laterals less the number of laterals tributary to the largest section, the total number of laterals less the number of laterals tributary to the largest and next to the largest sections, etc., X_1 X_2 etc. should be substituted for X and N_1, N_2, etc. substituted for N in Formula No. 1.

In a compound main serving one way laterals or in a compound lateral, equivalent quantities flowing must be determined for each separate section of the main or lateral and in formula No. 2, Y_1 Y_2 etc. should be substituted for Y and N_1, N_2, etc. substituted for N.

Values for X and Y.—Tables I and II have been prepared giving values of X and Y for various values of N as computed from Formulas Nos. (1) and (2).

The use of the above tables will be made clear by the following examples, in which a cast-iron pipe nomograph has been used for determining pipe diameters and head losses.

Use of Tables—Example I.—A filter has been designed up to the point of determining pipe sizes and the following data are established:

(a) Allotted loss for distribution system = 0.5 ft.
(b) Size siphon = 24 in.
(c) Main with 24 laterals (2-way) spaced at 8.5 ft.
(d) Distance from siphon to a point 8.5 ft. from first pair of laterals = 30 ft.
(e) Equivalent of 10 full ⅞ in. Taylor circular nozzles on 2 in. risers spaced at 9.83 ft.
(f) Discharge for one nozzle at maximum net head = 17 g.p.m.

1. The siphon size (24 in.) will be carried to a point 8.5 ft. from first pair of laterals. Loss in 30 ft. of 24 in. flowing $17 \times 10 \times 24 = 4080$ g.p.m. is 0.042 ft. We now have $0.5 - 0.042 = 0.458$ ft. as the allotted loss in the remainder of the distribution system.

2. For economical design we will allot about 75 per cent of the loss to the laterals and the remainder to the main. On this basis we will allot $0.25 \times 0.458 = 0.1145$ ft. loss to the main

$$= \frac{0.1145 \times 100}{12 \times 8.5} = 0.112 \text{ ft.}$$

per 100 ft.

3. From Table I for $N = 24$, $X = 14.7$
$14.7 \times 10 \times 17$ = equivalent quantity = 2500 g.p.m.

4. For a loss of 0.112 ft. per 100 ft. and a flow of 2500 g.p.m. a 21 in. main is required. The nearest commercial size is 20 in., so we will make the main of a uniform diameter of 20 in. from a point 8.5 ft. from the first pair of laterals, putting in a reducer at the designated point.

5. The loss in $12 \times 8.5 = 102$ ft. of

Table I. (For main with two-way laterals)

N=	4	6	8	10	12	14	16	18	20	22	24	26	28	30
X=	3.16	4.31	5.48	6.64	7.79	8.85	10.1	11.3	12.4	13.6	14.7	15.9	17.0	18.2

Table II. (For main with one-way laterals, or a lateral)

N=	3	4	5	6	7	8	9	10	11	12	13	14	15
Y=	2.16	2.74	3.32	3.88	4.47	5.0	5.58	6.16	6.75	7.32	7.90	8.50	90.7

20 in. main flowing 2500 g.p.m. = 0.143 ft. We now have 0.458 — 0.143 = 0.315 ft. as the loss to be allotted to the lateral including the entrance losses to lateral and nozzle riser. Ordinarily these two entrance losses will amount to less than 0.1 ft. so we have 0.315 —

$$0.1 = 0.215 \text{ ft.} = \frac{0.215 \times 100}{10 \times 9.83} = 0.219 \text{ ft.}$$

per 100 ft. as the frictional loss to be allotted to the lateral.

6. From Table II for N = 10, Y = 6.16.

6.16 × 17 = equivalent quantity = 105 g.p.m.

7. For a loss of 0.219 ft. per 100 ft. and a flow of 105 g.p.m.; a 5.8 in. lateral is required. Therefore we will use 6 in. laterals.

8. Our layout now comprises a 24 in. main extending from the siphon to a point 8.5 ft. from the first pair of laterals, a 20 in. uniform main in the bed, and 6 in. uniform laterals. We should now check the actual losses to be certain that the calculated losses for the system conform to the allotted losses.

Entrance loss to nozzle riser	= 0.024 ft.
Entrance loss to lateral	= 0.030 ft.
Loss through reducer neglected	= 0.000 ft.
Loss in 30 ft. of 24 in. Main	= 0.042 ft.
Loss in 102 ft. of 20 in. Main	= 0.143 ft.
Loss in 98.3 ft. of 6 in. lateral	= 0.170 ft.
Actual total distribution system loss	= 0.409 ft.
Allotted distribution system loss	= 0.500 ft. O.K.

The same actual total distribution system loss can be obtained by taking the sum of the two entrance losses, the separate losses in each section of the main between laterals and in each section of the lateral between nozzles, and the loss in the main between the siphon and the bed, but this is a laborious process which the system we propose avoids.

To illustrate the use of the above tables in connection with a compound main or lateral we will take the data in Example No. I and design a compound main so that the total loss in the main will be equal to the loss allotted to the main.

Use of Tables—Example No. II.—The 24 in. will be carried as in Example No. I, to a point 8.5 ft. from the first pair of laterals.

Allotted loss to the main = 0.1145 ft. = 0.112 ft. per 100 ft.

1. N_1 = total number of laterals = 24. From Table I for $N_1 = 24$, $X_1 = 14.7$.

14.7 × 10 × 17 = equivalent quantity = 2500 g.p.m.

2. For a loss of 0.112 ft. per 100 ft. and 2500 g.p.m. flowing, a 21 in. main is required, a 21 in. falling ¼ of the distance between a 20 in. and 24 in., above the 20 in. on the pipe diagram. Therefore, we will arbitrarily carry the 24 in. main from a point 8.5 ft. from the first pair of laterals to and including the third pair of laterals, which is ¼ of the total length of the main.

3. The loss in 25.5 ft. of 24 in. flowing 2500 g.p.m. is 0.015 ft. and the loss allotted for the remainder of the main is 0.1145 — 0.015 = 0.0995 ft.

$$\frac{0.0995 \times 100}{(102 - 25.5)} = 0.130 \text{ ft. per 100 ft.}$$

4. For the second section $N_2 = N_1 - 6 = 18$ and from Table I $X_2 = 11.3$.

11.3 × 10 × 17 = equivalent quantity = 1920 g.p.m.

5. For a loss of 0.13 ft. per 100 ft. and 1920 g.p.m. flowing an 18.3 in. pipe is required, 18.3 in. falling 0.3 of the distance between 18 in. and 20 in. above the 18 in. on the pipe diagram. Therefore, we arbitrarily will carry the 20 in. a distance equal to 0.3 of the remaining distance of 76.5 ft. = 22.9 ft. or to a point 5.9 ft. beyond the 5th pair of laterals.

6. The loss in 22.9 ft. of 20 in. carrying 1920 g.p.m. = 0.021 ft. We now have 0.0995 — 0.021 = 0.0785 ft. =

$$\frac{0.0785 \times 100}{102 - 25.5 - 22.9} = 0.146 \text{ ft.}$$

per 100 ft. as the allowable loss in the remainder of the main.

7. For the third section $N_3 = N_1 - 6 - 4 = 14$ and from Table I for $N_3 = 14$, $X_3 = 8.85$.

8.85 × 10 × 17 = equivalent quantity = 1500 g.p.m.

8. For an allowable loss of 0.146 ft. per 100 ft. and 1500 g.p.m. a 16.2 in. is required, 16.2 in. falling 0.2 of the distance between a 16 in. and 18 in. above the 16 in. on the pipe diagram. We arbitrarily will carry the 18 in. a distance equal to 0.2 of the remaining distance of 53.6 ft. = 10.7 ft. or to a point 8.1 ft. beyond the 6th pair of laterals.

9. The loss in 10.7 ft. of 18 in. flowing 1500 g.p.m. = 0.010 ft. We now have 0.0785 — 0.01 = 0.0685 ft. =

$$\frac{0.0685 \times 100}{102 - 25.5 - 22.9 - 10.7} = 0.159$$

ft. per 100 ft. as the allowable loss in the remainder of the main.

10. For the 4th section $N_4 = N_1 - 6 - 4 - 2 = 12$ and from Table I for $N_4 = 12$, $X_4 = 7.79$.

7.79 × 10 × 17 = equivalent quantity = 1360 g.p.m.

11. For an allowable loss of 0.159 ft. per 100 ft. and 1360 g.p.m. a 15.95 in. is required. Therefore, since a 16 in. is so close to the actual required size we will make the remainder of the main a 16 in.

12. Our layout for the main now comprises a 24 in. extending to a point beyond the third pair of laterals, a 20 in. extending to a point beyond the 5th pair of laterals, an 18 in. extending to a point beyond the 6th pair of laterals, and a 16 in. extending to a point beyond the last pair of laterals.

A compound main with one way laterals or a compound lateral can be designed by the same process with the exception that Table II should be used. After the various sizes are determined the losses should be checked to be certain that the total distribution system losses conform to the losses allotted to it.

In Example No. II the calculations have been carried out on the basis of showing that the losses in a compound main can actually be made to equal the predetermined losses for the main rather than on a practical basis. In the same way, the actual losses in a compound lateral can easily be made equal to the predetermined losses allotted to it. To adhere rigidly to the principle of making the actual losses in a compound main or lateral equal to the predetermined allotted losses will not always give practical results, and in order to secure a practical design it will be necessary for the designer to permit some variation in the percentage of the total loss to be allotted to the main or laterals. We consider the result obtained in Example I as practical and economical for the data used.

Acknowledgment.—The foregoing is taken from the April Illinois Engineer, the official publication of the Illinois Society of Engineers.

Cost of Water at Charleston, South Carolina

Some interesting statistics on the cost and income for water delivered to the distribution system of Charleston, S. C., are given in the 1928 report of J. E. Gibson, manager and engineer of the water department. The following table shows the average cost for the period 1921 to 1928 inclusive:

	Per 1,000,000 gal.
Pumping and Distribution:	
Operation and maintenance of mains	$ 8.99
Operating plant, including fuel and purifiers	33.58
Maintenance of machinery, buildings and filters	5.61
General officers, clerical assistants, insurance, legal and office expenses	20.35
Total, general, pumping and distribution	$ 68.53
Fixed Charges:	
Sinking fund and depreciation	19.63
Interest, bonds, loans and taxes	37.48
Interest on surplus invested in plant	19.67
Total fixed charges	$ 76.78
Extraordinary Expense:	
Drought, repairing, repairs, relocation of mains	8.84
Grand total, all expenses	154.15
Gross income from sale of water	167.81

Heavy Oil Tanks Moved on Greased Skids

A Universal crane and a track of well-greased plates were the means of moving two 10,000-gal. oil tanks, weighing 12,000 lb. each, a distance of about 250 ft. recently. The tanks were 28 ft. high and surrounding conditions necessitated moving them in a vertical position. The crane backed up to a tank, the hook block was fastened to the top of the tank and the bottom of the tank was lashed to the rear of the truck frame. When the tank was unfastened at its base, it was supported from the crane boom and skidded along a track of greased plates to its new position. The job cost the oil company $150.

Chlorinated Copperas and Ferric Chloride as Coagulants

A Recent Development in Water Purification Processes

By L. H. ENSLOW
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THE topic on which I am to speak—coagulation—is not new, but I believe the coagulant,—chlorinated copperas,—is new to most of those present. Neither of the components is new, but the combination of them to produce a coagulant is of rather recent development and its practical application in water purification is little more than a year old.

Coagulants.—The oldest known coagulants to be employed by man for clotting suspended particles in turbid water are the alums. The Chinese apparently practiced water clarification with alum before the Christian era. Artificial coagulation with aluminum salts has been materially improved within recent years as a result of a more scientific application and control of influencing factors such as the hydrogen ion concentration, better mixing arrangements and prechlorination of the raw water.

Long before the Chinese applied aluminum compounds artificially as coagulants Mother Nature had supplied the universe with a natural coagulant which contained the elemental substance on which all life is dependent, i. e., iron.

Water Coagulation Unassisted by Man.—In the natural decoloration and clarification of impounded waters it is known that iron and not aluminum is the responsible element. The soil and vegetation thereon contain iron in organic combination. The iron is liberated as ferrous iron as a result of subsequent anaerobic decomposition. In the ferrous state the iron will not precipitate until the surface contact with oxygen containing atmosphere produces ferric iron. In the ferric state the iron will combine with fresh organic coloring matter to produce flocculation and precipitation of the colloidal coloring matters. The reaction is apparently not one dependent upon ferric hydroxide formation and subsequent absorption of coloring matter, but rather consists of the production of a complex compound in which the negatively charged coloring matter is combined with the positively charged ferric iron to produce a bulky floc which settles. On reaching an oxygen deficient zone at or near the bottom of the water body, decomposition again releases some of the iron in the soluble ferrous form. Temperature changes or wind action produces an overturn of the stratified water and the iron again is reoxidized and further precipitation ensues. This cycle repeats to produce color removal and clarification.

Raw Water Prechlorination as an Aid to Coagulation.—Robert Spurr Weston[1] several years observed that color removal by coagulation with alum could be materially improved if the raw water was first chlorinated. His experience also showed that the alum required was thereby reduced. A number of experiences of similar nature have been reported since. Watkins at Norfolk, Va., has effectively employed prechlorination since 1923 and the plant of the Newport News Water Co. was also among the earliest to adopt prechlorination. Prechlorination at Norfolk has made it possible to reduce the alum requirement and thus effect an appreciable economy.

Several explanations to account for the improved coagulation effected by chlorination of raw waters have been advanced. In the writer's opinion, the presence of ferrous compounds in the raw water constitutes at least one valid explanation. The oxidizing effect of the chlorine renders the iron immediately effective as a coagulant whereas in the ferrous state it had no effect. In other words, chlorine does quickly that which nature performs slowly. Alone, the quantity of iron present may be only sufficient to secure "pin point" flocculation, but is sufficient to reinforce the artificial coagulant added and thereby a saving results. The iron oxidation theory seems to explain best the writer's early ideas that prechlorination appeared to serve as an artificial "ageing" process which rendered the coloring matter more readily coagulated. At Wausau, Wis., prechlorination of the raw water containing appreciable ferrous and sulphur compounds has indicated that an alum saving of 33 per cent can be expected.

Artificial Coagulation with Iron Compounds.—Ferrous sulphate ($FeSO_4$:$7H_2O$), known in the chemical trade as "copperas," has been employed in coagulation for many years. Copperas in coagulation work has always been used with lime in order that the ferrous iron will take up oxygen and pass to the ferric state. Because of the high alkalinity necessary (pH 9.0 or higher)[2] ferrous salts have, as a rule, not proved to be satisfactory coagulants for the soft colored waters, or for the soft turbid waters. Both of these types of waters usually coagulate efficiently only in the acid range, i. e., below pH 7.0, and the addition of alkaline material, if practiced, must be carefully controlled.

Ferric Chloride.—Ferric chloride ($FeCl_3$:$6H_2O$) is one of the oldest coagulants known. Its use was in vogue in the early days of chemical precipitation of sewages and is very apt to return to favor. It was employed as a water coagulant to a limited extent also and interestingly enough was used in Holland, under the guidance of Dr. Duyk in 1902, in combination with hypochlorites, thus simultaneously securing prechlorination. The process was termed the "Ferro-chlor Process," and has been favorably reported upon in America by Prof. Geo. C. Whipple.[3] Apparently the lower cost of aluminum sulphate has made the use of ferric salts unattractive. Recently, however, ferric salts have become available at attractive prices and probably their use will return to favor.

The investigations of coagulants by Miller[4] of the United States Public Health Service included ferric chloride and ferric alum in laboratory studies of water coagulation in which it has been shown that ferrous sulphate coagulated only at high alkalinities (pH 9.0 and above) but that ferric chloride coagulated satisfactorily at low alkalinities (pH 5:0) and also at various higher values. Mohlman and Palmer[5] of the Sanitary District of Chicago, in 1925 conducted important investigations in the coagulation of sludge from the activated sludge sewage process. In these studies ferric chloride was shown to be superior to all other coagulants, and functioned at very low alkalinities.

Chlorinated Copperas.—In searching for the cheapest available source of ferric iron it was but logical to consider the oxidation of copper as ($FeSO_4$:$7H_2O$) with liquid chlorine. This was successfully done, and this new coagulant—chlorinated copperas—while slightly less efficient than ferric chloride, proved to be vastly superior to alum in sludge dewatering. The method employed is given in the paper[6] cited. It served admirably at Chicago, was promptly investigated by Houston, Tex., and Milwaukee, Wis., and, with slight modification, was adopted.

The simplicity and the economy with which ferric iron is secured from the

cheapest available iron salt—copperas—and the cheapest and most powerful known oxidizing element known—chlorine—are appealing. The reaction involved is theoretically the following:

$$6FeSO_4 + 3Cl_2 = 2Fe_2(SO_4)_3 + 2FeCl_3$$

in which one pound of chlorine is required for 7.8 pounds of copperas.

$$Cl:FeSO_4 . 7H_2O = 35.46:278 = 1:7.8$$

In practice the ratio has proven to be 1 chlorine to 8 copperas.

The First Practical Use of Chlorinated Copperas in Water Purification.—For about one year chlorinated copperas has been in use at Elizabeth City, N. C., for coagulating the difficult and highly colored water from the Great Dismal Swamp area. To succeed with any process so radically new and different required ingenuity, perfection of practical arrangements, and tenacity on the part of L. L. Hedgepath,[67] then superintendent of the Elizabeth City plant. It was the good fortune of the writer to have interested him in experimenting with chlorinated copperas.

Producing Chlorinated Copperas Solution.—The arrangement for producing chlorinated copperas is very simple. It consists of a dry feed machine which delivers copperas to a small baffled solution vat beneath, and a chlorinator. The copperas in solution is conducted by gravity or, where necessary, by an ejector, through a corrosion resistant pipe line to the point of application to the raw water. Just beyond the copperas solution vat chlorine water conducted from the chlorinator is introduced into the pipe line through a rubber hose. Thus the chlorination of the copperas is effected during its passage to the point of application. Knowing the rate of delivery of the copperas required for the coagulant dosage, the chlorinator is set to deliver one eighth as much chlorine. It is better practice to add, as a margin of safety, about 10 per cent more than the theoretical calculated chlorine in order to preclude any possibility of passing ferrous iron into the water. The slight excess chlorine possesses a distinct value in improving plant performance because it serves in the capacity of prechlorination and is, therefore, not to be considerated wasted.

To date no other plants producing potable water have adopted chlorinated copperas on a practical scale. However, at a paper mill in Chicago where the foul Chicago River water is coagulated and filtered, chlorine and ferrous sulphate are producing results superior to the previously employed lime-iron coagulation. At this writing a demonstration is under way at a plant in Alabama.

A number of laboratory scale experiments have been carried on at several plants and almost without exception chlorinated copperas or ferric chloride has produced results which warrant large scale tests. Mr. Watkins of the Norfolk plants and Mr. Baldwin of the Richmond plant have carried out some small scale tests with chlorinated copperas.

General Remarks Concerning Ferric Iron Coagulation.—The range of alkalinity of the treated water in which ferric salts coagulate efficiently is very broad as compared to the ferrous salts or aluminum salts.

Where the removal of larger quantities of coloring matter is the problem the coagulation is most effective with little if any addition of artificial alkalinity. In some instances in connection with industrial waste—notably laundry wastes—addition of acid is beneficial. The optimum for very highly colored swamp waters is within the zone pH 3.8 to 4.7. This range is covered by Brom Cresol Green, and with Methyl Orange will indicate slight acidity to slight alkalinity.

Tannin is precipitated from tanliquors when acidified to a pH value under 4.6 and addition of alkali increases the solubility of tannin. The maximum dispersion occurs at pH 8.2 to 9.2 (i. e., in the normal carbonate range of alkalinity). This explains in part the failure of ferrous salts and lime in organic color removal and the inefficiency of aluminum salts at a pH value above 5.5. It may also explain the difficulty of removing color with alum without, at the same time, producing a filter effluent containing residual alum. At Elizabeth City, for example, the most effective color removal with alum is secured at a pH value not exceeding 4.9. In other instances the optimum is as low as pH 4.0. Under such conditions, aluminum compounds pass the filters.

Where the color removal is not so difficult and the amount is not large, ferric coagulation is effective over a wide range of pH value and in some instances it is possible to secure coagulation, color removal and carbon dioxide elimination with ferric iron and lime or soda at one operation, i. e., at pH values up to 8.2. On the whole, however, it is safer to recommend that color removal be practiced with the minimum required alkalinization or without any, and that pH adjustment to prevent corrosion be practiced after filtration, or just ahead of the filters if the latter practice proves to be more advantageous in securing longer filter runs.

When coagulating soft turbid waters carrying no appreciable soluble color the ferric coagulation is usually efficient at almost any pH value up to and including the point at which the corrosive quality has been corrected by alkali addition.

It seems apparent that in color removal the acidity (low pH value) plays an important role in inhibiting the formation of soluble or peptized iron compounds and encouraging the formation of bulky complex organic and basic ferric precipitates. These iron precipitates have adsorption properties far superior to the true ferric hydroxide floc. The higher the alkalinity, the greater is the tendency to produce hydroxide floc and consequently lowered efficiency in colloidal waters.

Because of the greater atomic weight of iron, the ferric complexes are higher in gravity than the similar aluminum complexes. The floc upon formation is very bulky but subsequently, at the bottom of the basins, shrinks markedly. The iron present is capable of combining with certain gases produced during putrefaction of organic sludges.

As to economy of coagulant—less ferric iron has been required than has been true of alum for the same result in connection with color removal. For turbidity removal the ferric salt required is less, although not as noticeably so as when dealing with color removal. The comparison is made on a pound for pound basis, employing commercial copperas ($FeSO_4:7H_2O$) which after chlorination has a 28.5 per cent Fe_2O_3 content as against ordinary filter alum containing 17 per cent Al_2O_3.

Cost Data.—Very little can be said at this early stage concerning cost of coagulation with chlorinated copperas or ferric chloride as compared with other coagulants.

At Elizabeth City the most recently available figure is $12.00 per m.g. when applying 3.25 grains per gallon of chlorinated copperas as the primary coagulant, and 0.75 grain per gallon of sodium aluminate as the secondary coagulant; this against a somewhat higher cost for alum and sodium aluminate. In addition, however, the better results from the ferric coagulant should be taken into account.

Recently figures have been secured to show the delivered cost of chlorine and copperas for producing chlorinated copperas at New York which yield the following data:

Material	Per cwt. Delivered
Sugar copperas in bags (car lots)	$0.65
Chlorine in one ton containers (15 tons per carload)	3.33

8 copperas + 1 chlorine, to produce chlorinated copperas, gives a chemical cost of $21.38 per ton of copperas chlorinated, i. e., roughly $1.07 per hundred. Employing copperas delivered in bulk cars the cost of chlorine plus copperas becomes $18.88 per ton, or $0.95 per hundred for a product having 28.7 per cent Fe_2O_3 content.

Milwaukee, Wis., is securing a 5-year supply of ferric chloride at approximately $0.95 per hundred (delivered Milwaukee) for a material containing 45 per cent $FeCl_3$, i. e., 21.6 per cent Fe_2O_3 equivalent. Approximately the same cost as that at Milwaukee will apply for ferric chloride at New York. The material is shipped as a solution in rubber lined tank cars, but the consumer pays only for the actual $FeCl_3$

content delivered, the manufacturer standing all freight charges, including that on the 55 per cent water content.

Chlorinated copperas may be produced either at Richmond or Norfolk, Va., at a chemical cost including all freight charges of:

Materials (including all freight charges)

	Cost per cwt.
Sugar copperas in 200 lb. bags (car lots)*	$0.775
Chlorine in 150 lb. cylinders (car lots)	5.75
Chlorine in one ton containers (15 containers per carload)	3.46

Employing the ratio of 1 chlorine to each 8 of copperas, the following costs per 100 lb. of copperas chlorinated result:

A: From chlorine purchased in 150 lb. cylinders:

100 lb. copperas	$0.775
12.5 lb. chlorine	0.719
	$1.494

B: From chlorine purchased in 2000 lb. containers:

100 lb. copperas	$0.775
12.5 chlorine	0.432
	$1.207

We believe that the economics involved and the proven efficacy of ferric salts as coagulants justify the consideration of the persons interested in water purification, sewage disposal and industrial wastes treatment.

* With copperas shipped in bulk, i. e., loose in the car, a reduction of $2.50 per ton for copperas is in order.

References

1. R. S. Weston, Jour. A. W. W. A., vol. 11, 1.446, 1924 Water Works, vol. 59, June 1923.
2. E. S. Hopkins, Journ. Ind. and Eng. Chem., vol. 21, p. 58, Jan. 1929.
3. G. C. Whipple, Proc. 26th Meeting of the A. W. W. A. 1906.
4. L. B. Miller, Public Health Reports, July 3, 1925. Public Health Reprint No. 1023.
5. F. W. Mohlman, J. R. Palmer, Eng. News-Rec., Jan. 26, 1928.
6. L. L. Hedgepeth, W. C. Olsen, J. A. W. W. A., vol. 20, p. 467, Oct. 1928.
7. L. L. Hedgepeth, Jour. N. Carolina W. W. A., vol. 6, p. 38, 1928.

Acknowledgment.—The above paper was presented April 26 at the First Virginia Conference on Water Purification and Sewage Treatment, Richmond, Va.

Channel Crossing Utilizes Flexible-Joint Pipe

In connection with the construction of the new West Side sewage treatment works of the Sanitary District of Chicago, it was necessary to carry a 12-in. water line across the main channel of the sanitary canal of the District. The illustration presented herewith depicts the method of making this crossing by assembling 12-ft. lengths of flexible-joint cast-iron pipe on a barge anchored across the channel and lowering the assembled line to the bottom of the canal.

Before installing the line in this manner the contractor made a test of the joints on shore. Several lengths of the pipe were joined and subjected to a pressure of 150 lb. per sq. in. with the test section in a straight line. This pressure was held while the joints were deflected 15 degrees and again brought to a straight line. No leakage being apparent, installation of the flexible-joint line was begun.

The submerged section of the crossing required 37 of the 12-ft. lengths. The joints were made up on the barge and on the shore. One end of the line was fastened at the shore-line and the other end was allowed to rest free on rollers so that the flexible string would slide down the bank and take its place at the bottom of the channel when lowered. As shown, each length of pipe was supported from the barge by a block and tackle. The lowering was carefully supervised, in order that no joint might be deflected an undue amount. Upon completion of the lowering, the free end of the flexible line was connected to the bell-and-spigot line on the shore. The completed line showed no leakage under a pressure of 150 lb. per sq. in.

By installing flexible-joint pipe in this manner, the services of a diver were not required except for inspection of the line.

FitzSimons & Connell Dredge & Dock Co. were sub-contractors for this work.

Iron Oxide for Gray Concrete

Colored concrete highways may serve as an intriguing variant of the present common white surfaces in the future. In discussing the sheet concrete pavements of Erie County, N. Y., George C. Diehl, county engineer, notes the instance of a high-grade residential development, the owners of which wished to get away from the white color of ordinary concrete. The pavement was given a slate-gray hue by including in the top-course mix 1 lb. of iron oxide per bag of cement.

Installation of 12-In. Line for the Sanitary District of Chicago. Joints Made Up and Line Suspended, Ready for Lowering

The Use of Rock Asphalt in Middletown, Conn.

Resurfacing Concrete and Macadam Pavements

By G. ALLEN SCHAEFER
Director of Public Works, Middletown, Conn.

MIDDLETOWN has done some very interesting work with rock asphalt within the last few years. The writer, therefore, felt that a brief outline of some of its operations would prove of interest.

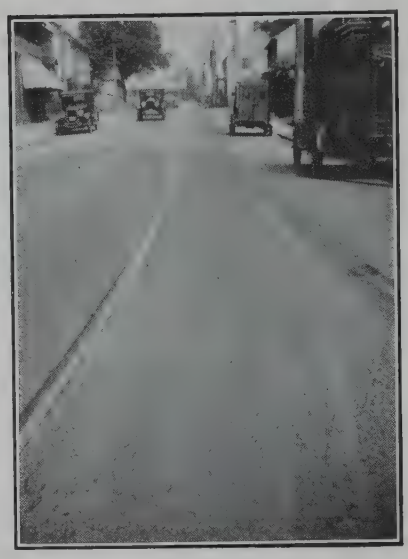
When the writer was appointed director of public works he became very much impressed with the material which his predecessor used in a limited quantity for patch work.

Resurfacing Worn Concrete Pavements.—After a very thorough investigation it was decided to use Kentucky rock asphalt for the resurfacing of Mount Vernon St. The existing pavement in the street was of cement concrete. This was very badly worn, especially along the trolley rails. In fact in many places the pavement heaved and was higher than the rails, concrete was chipped wherever such a condition existed and the entire area was then resurfaced from curb to curb featuring the Kentucky rock asphalt (Kyrock) to an edge where chipping was unnecessary.

Resurfacing Old Bituminous Macadam.—The residents along Mount Vernon St. and the officials of our city were so well pleased with the results that it was decided to continue our work with Kentucky rock asphalt during the year 1927. Washington St. was the first operation. The old bituminous macadam wearing surface was scarified wherever necessary. Two inch broken stone was added in sections where close examination proved the base to contain insufficient stone. The roadway was then reshaped and thoroughly rolled with a ten ton roller. The Kentucky rock asphalt (Kyrock) wearing course was applied in a layer 2¼ in. loose which compacted to 1½ in. Scarifying was done on that portion of Washington St. between Main and High St. The pavement between Vine and Thomas St. was not scarified. The surface was thoroughly broomed and then covered with an asphaltic paint having a penetration between 30 and 60. As soon as the paint became tackey the rock asphalt was applied as in previous operations.

Court St. from Broad St. to Valley RR. was resurfaced in a similar manner.

Disintegrated sections of the existing cement concrete pavements on Summer St. and South Main St. were resurfaced with rock asphalt the concrete surface being painted before applying the new wearing course material.



Resurfaced Concrete on Mount Vernon St., Laid in 1926. Picture Taken April, 1929

Part of Hartford Ave. which runs under the railroad bridge was also resurfaced. During the overflowing of the Connecticut River in October, 1927, approximately 3 ft. of water covered the rock asphalt surface for about two days. Although miles of pavement were ruined by the overflowing of this river the present condition of the underpass is as good as the day it was laid.

Rock Asphalt Wearing Course.—The work performed with Kentucky rock asphalt during 1927 was further proof to us that this material suited our needs, and it was therefore decided to continue the work with it. The first street to be built in 1928 was North Main St. a 6 in. compacted water bound macadam base built of 2 in. trap rock upon which was spread the Kentucky rock asphalt wearing course.

The following streets were also built in 1928 in similar manner: Johnson St. from North Main St. to Berlin Branch RR. College St. from Main St. to Broad St. Church St. from Broad St. to Hotchkiss St. Washington St. from High St. to Park Place. Berlin St. entire length.

Costs.—Approximately 2,760 sq. yd. were resurfaced by L. Suzio & Co. of Meriden, Conn., during 1927 at $1.80 per sq. yd.

In 1927 A. Brazos & Sons, Middletown, was awarded the contract. Approximately 20,000 sq. yd. were resurfaced at the following unit prices:

Scarifying 15 ct. per square yard.

Broken stone rolled in place $3.50 per ton.

Kentucky rock asphalt (Kyrock) wearing surface $1.62 per square yard.

A. Brazos & Sons were again the successful bidders in 1928. The unit prices on approximately 30,000 sq. yd. were:

Excavation $1.15 per square yard.

Broken stone rolled in place $3.50 per ton.

Kentucky rock asphalt (Kyrock) wearing surface $1.50 per square yard.

The average cost of completed pave-

Spreading Rock Asphalt on 6 in. Macadam Base in 1928 on Church St.

View of Church St., in April, 1929

ment on work performed during 1928 was $3.00 per square yard.

The writer's close observations of the completed rock asphalt pavements proved to him that such a wearing course improves with age. There appears to be absolutely no rolling, shoving or creeping of the material. The Silica sandstone aggregate gives it the non-skid quality which in the writer's opinion is worthy of very serious consideration especially when deciding upon pavement for a street having an appreciable grade. All cracks appearing on the surface due to the opening of the base knit under traffic within a comparatively short time.

All operations were under the personal supervision of the writer as well as the engineers of the Kentucky Rock Asphalt Co. The wearing course was laid in each instance in accordance with the specifications of the Kentucky Rock Asphalt Co.

Coagulation of Highly Colored Waters

Prechlorination and Filtration at Norfolk, Va.

By WILLIAM W. WATKINS
Chief Chemist, Bureau of Water, Norfolk, Va.

ABOUT a year after taking charge of the Norfolk, Virginia, filter plant in 1922 the possibilities of using liquid chlorine to reduce the amount of alum necessary to coagulate the highly colored waters were taken up and it has proven that a material saving in dollars and cents as well as a better quality of water could be produced by the addition of liquid chlorine to the raw water.

In any discussion of Norfolk's water supply it is necessary to always keep in mind the fact that there are two supplies and that while they have the same general method of purification the differences will only be touched on in this paper.

Norfolk's Water Supply. — The Moores Bridges plant is located on the edge of Princess Anne County about six miles from the heart of the city. The water is impounded in a series of lakes connected by canals. These lakes were old salt water inlets dammed off from Chesapeake Bay and allowed to freshen up. This supply has been in use for about 50 years and at the present time furnishes about 60 per cent of the daily consumption. The filter plant was built in 1898 and revamped in 1921.

While this water will run an average color of 50 to 60 on the platinum cobalt scale it occasionally reaches the color of 160 for a few days at the time. The turbidity will average about 25 but owing to the topography and cultivation of the surrounding country it sometimes runs to 5000. The free carbon dioxide is very susceptible to seasonable changes but the alkalinity to methyl orange (30 p.p.pm.) is fairly constant throughout the year except after very heavy rainfall when it becomes necessary to add soda ash to replace the natural alkalinity of the raw water lost by dilution.

The Lake Prince Filter Plant is located on 37th Street near the Lambert Point coal piers. Lake Prince, itself, holding about 3.7 million gallons of water, is located in Nansemond County about 6 miles southwest of Suffolk. Water from Lake Prince is pumped to the filter plant through 20 miles of woodstave, concrete and cast iron pipe with crossings under the Nansemond and Elizabeth Rivers.

This water carries a higher color than Moores Bridges, averaging around 70. In the three years of its operation the turbidity has never reached as high as 50 but the color has been as high as 200 for periods of ten days. With an average alkalinity of 40 p.p.m. and a pH of 7.0 no artificial alkalinity is necessary for coagulation.

The combined capacities of the two plants is 28,000,000 gal. daily, the average consumption being about 12,500,000 gal. per day either plant is capable of carrying the load, but owing to the balancing of the pressure it is found to be more economical to run on a 7 to 5 basis, that is 7 million at Moores Bridges and 5 at Lake Prince.

The Former Treatment.—Prior to November, 1923, the general method of treatment at the Moores Bridges plant can be briefly summarized. Aluminum sulphate in the average of 2.00 grains per gallon was added to the raw water, which was allowed to settle for 4 hours, filtered through rapid sand filters, CO_2 reduced with hydrated lime, and chlorine added for sterilization. In addition, chloride of lime was added to the wash water and tons of copper sulphate were used annually to keep down algae. The average percentage of wash water was 4 to 5 per cent. The average filter runs were about 16 hours.

In the fall of 1923 experimental work was done on the use of liquid chlorine to assist in the coagulation of the water. The work was carried on experimentally for about a year after which time it was decided to make a permanent installation of the chlorine machine.

Application of Chlorine.—The chlorine was applied to the raw water in the mixing chamber about one minute ahead of the alum. It was found that best results could be obtained by adding approximately 6 pounds of chlor-

Resurfaced Old Macadam Constructed in 1927 on Washington St.

ine per million gallons of water. This would give a residual of 0.1 p.p.m. ten minutes after application or as the water passed from the mixing chamber into the coagulating basin. Higher residuals did not seem to lessen the quantity of alum used at all. Unless 0.1 residual was carried no results in reduction were obtained.

Before prechlorination or what should be more properly called split-chlorination, was tried, it required from 4 to 6 lb. of chlorine per million gallons of water for sterilization. With the split dosage it required 5 lb. for the prechlorination and 2 to 3 for sterilization. The Lake Prince plant was not operated long enough before split-chlorination was adopted to have any data on alum alone to work from. When prechlorination was tried out at that plant it was found that 7 lb. per million gallons of water gave the best results. This gives a residual of 0.2 p.p.m. 20 to 30 minutes after application. When the Lake Prince plant was put in operation a good deal of trouble was experienced with algae—asterionella being the type giving the taste and odor troubles. For reasons governed by local conditions it was not desirable to use copper sulphate so prechlorination was adopted as regular routine and has been found very effective in stopping algae taste and odors.

Results of Prechlorination.—Aside from the actual amount of alum saved it is found to be much easier to get the maximum color removal with split chlorination than with alum alone. The length of the filter runs were increased from 16 to 24 hours, and the filter beds are kept in much better condition by the use of split-chlorination.

A marked reduction in the bacterial loading was noted with the prechlorination dosage as applied. While Norfolk still adds chlorine for sterilization purposes it is done as an added precaution rather than as a necessity.

I know of no better way to give you my reasons for the continued use of a split dosage of chlorine than to quote from a report written several years ago to Mr. W. H. Taylor, Director of Public Works, Norfolk.

"I find that I can save from 0.4 to 0.6 grains per gallon of alum by the use of 6 lb. of chlorine per million gallons of water. The lower dosage of alum gives a lower free carbon dioxide content and for that reason I am able to save some lime. (The fact that the carbon dioxide content is so variable in the raw water makes it very hard to get the exact quantity of lime saved). However, to offset the saving in lime there is the increase in the amount of chlorine fed. Formerly I used 5 to 6 lb. per million gallons of filtered water but now I use about 9 lb. for the combination of prechlorination and sterilization.

Aside from the saving in alum the greatest advantage of prechlorination is in the saving of copper sulphate and wash water. Prior to prechlorination there were times when it was impossible to get filter runs of over 6 hours without the use of copper sulphate. Since I have been using chlorine the minimum average for a two-year period is a twelve-hour run, maximum being well over 20 hours. During this period no copper was used. As well as I can estimate the saving is about a dollar a day on the wash water end of it.

There is another item which cannot be put down in dollars and cents and that is the condition of the filter beds, which are in much better shape than formerly.

I am confident that the City of Norfolk is saving from $5.00 to $7.00 per day on alum, lime, and wash water, leaving the question of copper sulphate and filter beds out of the consideration.

Red Water Troubles.—In Norfolk, as in all other cities on the Atlantic Coastal Plain, which have soft colored waters we have our red water troubles. Perhaps I should say had our red water troubles, for we have cut down the number of complaints to those few who grumble for the sheer love of grumbling. We do not feel, however, that the problem is entirely solved and at the present time we are considering the use of caustic soda.

When hydrated lime was first used in 1922 only enough was used to reduce the free carbon dioxide to 5 p.p.m. or less. That helped but was not sufficient and at the present time enough lime is added to give a pH of around 8.6 to 9.0 with a phenol alkalinity of 6 to 8 p.p.m. What red water we do get is in dead ends and it is my firm belief that it is due to dissolved oxygen. I have not been able to establish this as a positive fact but everything points in that direction. In winter when the dissolved oxygen is greatest, 8 to 9 p. m., we have most of our trouble.

Acknowledgment.—The foregoing is a paper presented at the First Virginia Conference on Water Purification and Sewage Treatment.

Mosquito Extermination Scientific in Winnipeg

Mosquito extermination in Winnipeg, Canada, is carried out in a scientific manner under Mr. Eric Hearle, expert entomologist, who directed the research in the identification of the types and habits of the mosquitoes of the district, according to the annual report of the Public Parks Board of that city. Plans for continuous annual effort were mapped out.

According to the Toledo City Journal active extermination work by oil spraying was carried on within a radius of two miles of the city's center and for a like radius of the suburban parks and municipal golf courses. Large areas of shallow, stagnant water, forming ideal breeding pools, which were caused by the heavy rainfall, were sprayed, and excellent results obtained.

Ice Diaphragm Aids in Placing Concrete Under Water

An ingenious scheme used for cutting off salt water encountered in the drilling of a deep well at the new Proviso yard of the Chicago & North Western Ry. was described by G. A. Saint, assistant engineer with the North Western, in a paper presented before the Western Society of Engineers.

It was important that an adequate supply of soft water be provided for locomotives; hence as large a well as possible was sunk. A shaft 20 in. in diameter was sunk to a depth of 2,100 ft., at which level a pumping test was made. This test was judged unsatisfactory, as a flow of 250 gal. per minute was all that was obtained. It was decided to go deeper, and the well was sunk to a depth of 2,250 ft. A 1,600-ft. length was cased off to get rid of the hard water at the top. A second pumping test, made at the 2,250-ft. level yielded satisfactory results as to capacity, showing a flow of 400 gal. per minute. However, an analysis of the water showed the presence of 28 grains of salt per gallon, indicating that the water would be unfit for boiler use, and that some means of eliminating the salt would have to be found.

Since water from the 2,100-ft. level contained no salt, it was decided to fill the bottom 150 ft. of the well with concrete. This raised the problem of lowering the concrete through about 2,100 ft. of water without separating out the cement and finer aggregates. Following the suggestion of an old-time well driller, the concrete was lowered in a section of steel casing, 12 in. in diameter and about 12 ft. long. Two pins were placed across the bottom of the casing and a piece of ice about a foot thick was trimmed to rest on the pins and stop up the bottom tightly. The ice was placed in the casing, the remainder of the shell was filled with the concrete mix, and the whole was lowered to within a few feet of the bottom. The temperature of the water was about 60 deg. and the time of lowering was approximately 3 minutes. When the ice melted, the concrete ran out the bottom of the casing and filled up the hole.

Proviso yard covers an area of 1,500 acres just west of the city of Chicago, has a total track mileage of 230 miles and involves an authorization to date of $10,000,000. Completion of the project as contemplated will call for the expenditure of at least $5,000,000 more.

Protecting Exposed Pipe Lines

Pipe lines which must be carried over bridges may be protected from freezing temperatures by placing the pipe in a wooden box and filling the space about the pipe with an insulator such as sawdust or mineral wool.

Garbage Incineration at Toronto, Ont.

Operation and Costs of Disposal in 1928

DURING 1928 the destructor plants of Toronto, Ont., handled over 159,000 tons of household garbage and combustible material at a cost of $1.26 per ton. Some interesting facts on the operation of these incinerating plants is given in the 1928 report of George W. Dies, Street Commissioner of Toronto.

The Don Destructor.—The Don destructor was completed in July, 1917, at a total cost of $225,000, exclusive of land. The plant is of fire-proof construction throughout, and consists of three high-temperature four-cell furnace units, with combustion chambers, connecting flues, regenerators, and all appurtenances. The radial brick chimney is 25 ft. from the outside of the building, and is constructed with a self-supporting refractory lining, extending from the foundation to the top of the chimney, the inside of which is 90 in.

The overall height of the chimney, including the octagonal base and radial column, is 175 ft.

During 1928, 53,961 tons of refuse were disposed of at a total cost of $1.46 per ton, or 2.4 man hours of labor per ton. This total unit cost is based upon the total operating cost of the plant for the year, which includes tipping-floor man, charging men, stokers, ash-run men, removal of ash residue, supervision, weight scale clerk, privileges accorded employees, consisting of a half-day off per week with pay, all statutory holidays, two weeks' holidays, one month's sick pay, supplies and repairs to plant and building.

The plant has a guaranteed capacity of 180 tons per 24-hour day, but it destroys on an average of 200 tons per 16-hour day. The reduction by weight of the refuse delivered to the plant is 89 per cent.

The material delivered passes over a weigh-scale platform, where the weight is recorded. It is then drawn into the plant on to the tipping floor, where the vehicles are backed, and the contents dumped to the charging floor below. From that point it is charged into the containers of the furnaces by the charging men. The dumping of the containers is controlled from the stoking floor level, compressed air rams being provided for operating the furnace covers and the container doors. The refuse passes through the opening and drops upon a drying hearth inside and at the back of the furnace; it is then drawn over and spread on the grates, where incineration takes place. After the residue has accumulated to such an extent so as not to retard effective burning, large counter-balanced doors at the front of the furnace are raised, and the residue is removed from the grates, dropping by gravity through openings on the stoking floor, falling into steel side-dump cars (located in what is known as the ash run) of about one and a half cubic yards capacity. The trucks are moved over a narrow gauge track and placed upon an electrically-operated freight elevator, which raises the residue to the ash bin on the tipping floor level. On this floor a weight scale is provided, which records the weight of the residue before dumping it into an elevated ash bin. The removal of the residue is effected by means of adjustable chutes, through which it flows into any desired vehicle, at grade level. It will be noted that the system is gravity throughout, with the one exception, where the residue is raised from the ash run to the bin on the tipping floor level.

The furnaces are what is known as the continuous grate regenerative type, the cells are divided by low-set air-cooled surrounding castings which renders it possible to fire and clean the grates in an individual manner. The gases pass over the cells into the combustion and settling chamber; at the back end of this chamber a firebrick dividing arch is constructed, that splits the gases, a requisite portion of which pass into the air heater or regenerating chamber, the air heater being designed for pre-heating the forced draught. Any gases not otherwise utilized pass into the by-pass flue, through the connecting flues which are coupled to the main flue, and from thence into the chimney.

Wellington Destructor.—The Wellington destructor was placed in operation in April, 1925. The total cost of the plant amounted to $550,000, exclusive of land. The entrance to the plant is by an approach 250 ft. long and 24 ft. wide, with a 4 per cent upgrade. A 25-ton weigh scale is located on the causeway immediately in front of the entrance to the tipping floor.

The main building is 180 ft. long, and 100 ft. wide, with roof trusses spanning the entire width, and covered with a reinforced concrete roof upon which felt and gravel roofing is laid. The roof is designed with a monitor extending almost the full length of the building. The monitor is equipped with ventilating louvres. The building throughout is of fireproof construction. There are four floors at different levels. The vehicles entering the plant from the approach on the tipping floor level. The tipping floors extend nearly the full length of the building and are 35 ft. wide, connected by a bridge across the charging floor 20 ft. wide, thereby making it possible in an emergency to dump on each side of the charging floor, which is 10 ft. below the tipping floors.

This charging floor extends the full length of the building, and it is 15 ft. wide each side of the charging containers, which are located on the longitudinal center line of the building. The stoking floor as well as the main floor is 18 ft. below the charging floor level. These floors also represent the low grade level. Another floor, known as the ash-run floor, is 8 ft. below grade.

The capacity of the charging floor is such that it is possible to store sufficient material in an 8 hour delivery to operate the plant 24 hours.

The equipment of the plant consists of four 4-cell furnaces complete, with combustion chambers, air heaters, connecting flues, main flues and two radial brick chimneys, and all appurtenances, including forced draught equipment, air compressors and temperature recording instruments.

The general arrangements of the flues are such that it is possible to operate any desired battery of three furnaces together with any one chimney (each chimney being capable of operating three furnaces in battery), so that at all times the plant may be operated at not less than 75 per cent capacity.

Dual air compressors are provided so as to be capable of furnishing a constant supply of air for operating the container doors and furnace covers.

The Wellington destructor has a guaranteed capacity of 400 tons per 24 hours, but has during the summer months destroyed 350-400 tons per 16 hour day.

The opening of this plant in 1925, replaced the old Western Crematory on

Summary of Operation of Don Destructor, 1917-1928

Year	Total Labor Cost	Labor Cost and Maintenance	Tonnage Destroyed	Labor Cost per ton	Total Cost per ton
1917	$12,783	$16,053	12,699	$1.00	$1.26
1918	29,874	39,369	27,303	1.09	1.44
1919	27,397	41,060	27,811	1.02	1.47
1920	38,407	53,271	33,688	1.14	1.58
1921	54,237	66,760	47,392	1.14	1.40
1922	55,529	74,640	49,842	1.11	1.40
1923	54,292	69,098	44,673	1.21	1.54
1924	58,889	74,458	50,985	1.15	1.46
1925	63,147	75,648	50,159	1.25	1.50
1926	68,557	79,500	52,081	1.31	1.52
1927	66,462	74,539	51,089	1.30	1.46
1928	70,450	78,701	53,961	1.31	1.46

Summary of Operation of Crematory and Wellington Destructor, 1917-1928

Year	Total Labor Cost	Labor Cost and Maintenance	Tonnage Destroyed	Labor Cost per ton	Total Cost per ton
Crematory—					
1917	$14,487	$15,382	19,381	$0.75	$0.79
1918	16,387	19,926	18,615	.88	1.07
1919	20,889	25,725	20,751	1.00	1.23
1920	26,602	35,062	18,815	1.41	1.86
1921	29,589	35,184	21,680	1.36	1.62
1922	29,183	33,452	19,467	1.49	1.71
1923	33,016	35,769	26,638	1.23	1.34
1924	32,328	35,526	24,127	1.33	1.47
Wellington Destructor—					
1925	$64,966	$70,448	63,351	$1.02	$1.10
1926	72,475	79,467	69,822	1.03	1.13
1927	76,095	84,142	77,134	.98	1.09
1928	80,876	90,059	80,471	1.00	1.12

Strachan Avenue, a plant which had been in operation for over 30 years. It consisted of two furnaces, operating under natural draught, and disposed of 80 tons of refuse per 16 hour day. While the crematory was of rather antiquated design, and the building portion was in latter years beyond repair, it served its purpose well, and was no doubt a modern plant at the time of its construction.

The total labor cost includes all labor engaged in the disposal of the refuse, supervision, weigh scale clerk, and privileges accorded employees. The labor cost and maintenance includes the total labor cost, plus repairs to plant and building, supplies and equipment, which is the total operating cost of the plant for the year. The ash residue amounts to 11.2 per cent of the total tonnage destroyed.

Island Incinerator.—The Island Incinerator is situated at Centre Island. It was placed in operation in 1915 at a cost of $25,000, exclusive of land. The plant consists of one burning unit operating under natural draught, and destroys all garbage, rubbish and night soil collected upon the Islands. No fuel is used to augment the fires.

There is only one stoker engaged at this plant, and during 1928, 648 tons of material were destroyed, at a total cost of 2.3 man hours of labor per ton. The total operating cost of the plant during 1928 amounted to $952.80.

The collection and disposal services at the Island commence in the early part of May and terminate in October. The consistency of the material collected is considerably heavier than that removed in the City, and is principally composed of table refuse and night soil. The material is collected in metal receptacles and conveyed by horse and cart to designated points where the cans are transferred to a five-ton workboat, which conveys the refuse to the incinerator dock. The cans are placed upon a push truck operating upon narrow-gauge rails and moved into the building, then raised by elevator to the charging floor. The receptacles are emptied into the charging holes where the refuse falls upon the drying hearth, to be later distributed over the grates by the stoker.

The Island collection service is rendered by a foreman, two drivers and vehicles, two laborers, and a work-boat, the foreman being responsible for the operation of the boat. The service is under the supervision of the Superintendent of the Eastern Division, and during the season of 1928 was performed at a total cost of $4,988.30, which cost is included in the general summary of the refuse collection service.

The total labor cost includes all labor engaged in the disposal of the refuse. Labor cost and maintenance of plant and building, supplies and equipment, which is the total operating cost of the plant for the year. The ash residue amounts to approximately ten per cent.

Summary of Operation of Island Incinerator, 1921-1928

Year	Total Labor Cost	Labor Cost and Maintenance	Tonnage Destroyed	Labor Cost per ton	Total Cost per ton
1921	$576	$ 697	668	$0.87	$1.00
1922	662	755	744	.88	1.01
1923	633	1,200	671	.94	1.79
1924	729	994	716	1.02	1.31
1925	763	966	701	1.08	1.41
1926	720	1,024	656	1.15	1.56
1927	758	978	663	1.14	1.48
1928	690	952	684	1.02	1.39

Flushing in Backfilling

The problem of backfilling trenches in such a manner that the maximum amount of dirt excavated will be replaced and the fill thoroughly settled is one which confronts contractors in sewer and water-supply work. It will generally be found that flushing the trench produces better results than hand tamping if the puddling operation is performed properly and if the soil is not clayey.

To secure the most complete settlement, fill the ditch with dirt, piling the excess over the fill, and flush the trench from the bottom. A pipe may be attached to the end of the hose and pushed through the dirt until it strikes the sewer or water main. The water should be allowed to flow until it reaches the top of the trench. This operation is repeated at intervals along the pipe line, the length of intervals depending upon the nature of the soil and the size of the trench. Flushing should never be done from above, as the puddled earth is likely to lodge part way down the ditch, preventing proper settlement of the bottom of the fill. Contractors who have relied upon hand tamping may be surprised to find the judicious use of water producing a settlement of 1 or 2 in. in an ordinary hand-tamped fill.

In sewer work, there is danger from the collapse of manholes during backfilling. If the flushing method has been used, the collapse of a manhole may introduce water into the sewer, resulting in damage to the work or injury to the workmen. Care should be taken to maintain a uniform pressure on all sides of the manhole during backfilling.

Sanitary Engineering Courses

The data concerning sanitary engineering courses in colleges in the United States, prepared in 1924 by Isador W. Mendelsohn, Associate Sanitary Engineer, U. S. Public Health Service, has now been brought up to 1928. The data for the later year are given by Mr. Mendelsohn in a comprehensive article in the March 22 issue of Public Health Reports. He summarizes his findings as follows:

1. There are 16 colleges in every section of the United States at present offering either regular or optional courses in sanitary engineering.

2. There is considerable difference of opinion among the universities as to the fundamental concept of a sanitary engineering course.

3. The sanitary engineering courses are in reality civil engineering courses with certain appended subjects, such as water supply, sewage disposal, the bacteriology and chemistry of water and sewage, and a little public health.

4. Emphasis in both sanitary engineering and public-health subjects reflects in practically all the institutions the personality of the professor of sanitary engineering.

5. The number of sanitary engineering graduates annually is increasing.

6. There is a great variation in the degrees granted by the institutions for equivalent work and also in the names of the course.

7. In 4 of the 16 institutions the term of sanitary engineering course is either five or six years.

Municipal Reference Libraries.—The 15 cities of the United States that have municipal reference libraries are: Baltimore, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Portland, Ore.; Rochester, St. Louis, Seattle and Toledo.

Recording Operating Data on Filtration

Keeping Books on the Filter Plant

By WELLINGTON DONALDSON
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IN the furnishing of drinking water to a community, the water plant operator occupies a position of very high trust in safeguarding water consumers from water-borne disease, in addition to his obvious responsibility for providing a water of acceptable physical qualities. The possible consequences from improper operation of water purification works are too serious to permit such works to be run in a loose unsystematic manner without adequate records of their performance.

Value of Plant Records.—Aside from the value of plant records in fixing responsibility they have a very definite value to the operator in allowing comparison to be made of results from day to day, month to month, etc., of his own plant and of other plants as well. By such comparison much can be done in smoothing out operation and promoting plant economies.

Adequate records of plant operation comprise the following:

(a) Primary records of quantities, water quality and such details as are useful in controlling the plant.

(b) Summaries of the essential information contained in the primary records.

(c) Reports to department head or responsible supervising authority at stated intervals.

Primary Records.—What primary records should be made? Naturally this depends a great deal on the size of the water plant, the quality of the supply, the nature of treatment and the character of operating personnel. Take for example the typical rapid sand filter for a surface supply. The minimum records that could be recommended are as follows:

(a) Amount water treated, thousand gallons.

(b) Chemicals used in treatment, lbs.

(c) Number filters in service.

(d) Number filters washed.

(e) Amount of wash water, thousand gallons.

(f) Average filter runs between washings, hours.

(g) Turbidity of raw and delivered water.

(h) Color of raw and delivered water.

(i) Residual chlorine of delivered water.

(j) Bacterial tests for B. coli and total bacteria.

Some amplification of this minimum schedule will be called for to meet local conditions. For instance, where the filtered water is pumped, the water elevation of the reservoir, the duration of pumping and power required are pertinent items. Tests for alkalinity or pH are sometimes necessary for intelligent coagulation control.

To be useful for ready comparison the chemicals used should be shown on the unit basis (pounds per million gallons, or grains per gallon), and the wash water as per cent of treated, in addition to total amounts.

The cost of operation is not included in the above list because this information although of considerable importance is seldom available to the plant operator. He can easily however show the chemical cost per million gallons, each day.

The Most Important Item.—Of the items listed above, without doubt the last or bacterial test is the most important, for assurance of the hygienic quality takes precedence over any other kind of record. In the smaller filter plant, however, the bacterial tests are made by some laboratory not connected with the water department. Very fortunately the small plant operator without any knowledge of bacteriology may have assurance of getting good bacterial results from his plants by means of the simple test for residual chlorine, which any filter operator can make.

Means for obtaining the amount of water treated is sometimes lacking, where centrifugal pumps are installed, and where the cost of a Venturi or some other type of flow meter was not felt to be justified.

Recording the Chemicals.—It is a comparatively simple matter to keep track of the chemicals used each day, but experience shows that frequent mistakes are made in recording this item. In theory each pound of chemical applied to the water should pass over the scales, so to speak. Alum, hydrated lime and soda, however, are available in containers of sufficiently standard weight to be relied upon, but where these original sacks or barrels are broken, to make up charges, scales are necessary to keep track of the actual amount of chemical fed into the water. The weight of chlorine cylinders should invariably be gotten from platform scales, devoted to that purpose alone. When solution tanks are used for alum, mistakes are frequently made in reporting the total pounds per day due to changes in the tank charges or carelessness in filling to a fixed mark. With dry feed machines, errors in reporting are common, due to depending on calibration of the dry feed machines and where no check is made by scale weight of the alum going into the hoppers.

In case of special purification plants such as iron removal, softening, and slow sand filters, the essential data to be reported must of course be adapted to the particular plant and will differ from the essential items given above for the surface water supply.

Manner of Keeping Data.—The manner in which the essential data of operation are kept depends upon the size of the plant, the operating personnel and the quality of the water supply. Where the filter plant operator is the general factotum of the water works and attends to pumping and repairing the mains, and possibly to the collection of water rents, perhaps there is nothing better than a substantial book ruled to suit the data to be recorded say on the basis of a daily entry. With larger plants printed log sheets are desirable either on a daily or weekly basis. The log sheet is particularly desirable where there is more than one operator in order to definitely fix responsibility for happenings on the shifts.

The frequency of taking and recording readings of meters, gages, chlorinators, chemical feeds, etc., should be adjusted on a common sense basis to the local conditions. In larger filtration plants it is customary to use log sheets providing for readings each hour or sometimes at two or four hour intervals. That this matter can be overdone is shown very well by the example of one city of about 50,000 people, within the speaker's observation, where the filter attendants on 8-hour shifts are kept dressed in natty monogrammed uniforms and required not only to record numerous observations each half hour, but to plot curves. They complained very properly that they were kept so busy making records that they had no time left to run the plant.

Summarizing the Records.—Next in importance to keeping good records is the summarizing of these records into condensed form where they may be easily referred to. It is a common fault of many water plants and other business enterprises as well that much valuable detailed information becomes unavailable from lack of suitable summaries systematically carried forward. As a general proposition a summary by months is the most convenient way of keeping the operating data in shape

for ready use. Printed forms are most suitable for this purpose.

It is seldom that the filter operator is given complete discretion in all matters relating to his plant. He usually has to make a report to somebody to show what is going on at his plant. The form of report is determined by the local organizations and the ideas of the executive or official in charge. Large water departments generally insist on a daily report of operations. A weekly report is preferred by many of the utility companies which operate a number of properties. A few of the state boards of health also require a weekly report of filter plant operation. The State Board of Health in this state and in a number of other states require monthly reports of operation.

A rather unusual situation came to the speaker's attention some years ago where a city of about 50,000 population had a fine new filter plant with a competent chemist in charge. He had suitable record and report forms printed to show his operation, but when his first reports went to the City Hall, he was called on the carpet and instructed by the newly appointed water commissioner to desist from sending in any reports of this kind because he didn't want them and didn't know what they meant anyhow. Happily such conditions are rare.

Recording Operating Data Not Difficult.—The recording of operating data and the making out of reports appears to be quite a task for some operators who have not been fortunate enough to secure a good education. The speaker recalls one instance where he labored with the pumping station engineer to get him to figure his chlorine dose each day. More than once the old man threw down his pencil in disgust with the exclamation that he "was hired to run the pumps and not to figger." Patience finally won, however.

The filter plant operator who happens to be lacking in good education or technical training can take comfort from the writer's assurance, based on many years of filter plant supervision, that the best records are not necessarily made out in the best handwriting nor couched in the most grammatical language. One of the most poorly operated filter plants that he recalls was in charge of a Ph.D. while one of the best cared-for filter plants was in charge of an unlettered fellow to whom a decimal point will always remain a mystery. His records were naturally crude and hard to decipher but they served their purpose admirably. He knew what was needed to be done to keep his plant in first-class condition and he did it. The main thing about him was his mental honesty and his thorough dependability, without which qualities plant records mean very little.

Acknowledgment.—The above is a paper presented at the First Virginia Conference on Water Purification held at Richmond, Va., April 25 and 26.

Inventory of Water Supply of Pomperaug Basin

For many years the Geological Survey of the United States Department of the Interior has been actively engaged in measuring the flow of the rivers and creeks of the country and in determining the quantities of surface water that percolate down to the water-bearing rocks and can be recovered through artesian wells or by pumping. At the same time the Department of Agriculture has endeavored, by elaborate investigations, to determine the amount of water that seeps into the soil, how much of it is consumed by vegetation, and what becomes of the rest. In a Geological Survey report just published (Water-Supply Paper 597-B), by O. E. Meinzer and Norah D. Stearns, an attempt is made to present, for a period of three years, a monthly and yearly inventory of the water supply of the Pomperaug Basin, a more or less typical drainage basin in Connecticut. This paper was prepared in cooperation with the Connecticut State Geological and Natural History Survey.

The problem of the circulation and storage of the water derived from the rain and snow that fall on the Pomperaug Basin is analyzed comprehensively in this report. A part of this water is intercepted by trees and other vegetation, from which it evaporates and is returned to the atmosphere without reaching the ground; a part is evaporated directly from the surface of the ground; a part flows directly into the streams and ponds and runs off, except a small amount that is lost by evaporation; a part percolates into the ground and becomes soil moisture, or penetrates to the water table, where it enters the zone of saturation and is called ground water. The soil moisture may be absorbed and transpired by plants or may be evaporated directly from the soil. The water in the zone of saturation may be transpired by plants or may evaporate where it comes near the surface, or it may seep into the ponds and streams eventually and be carried out of the basin by the Pomperaug River.

It is believed that practically no water is lost by deep percolation out of the Pomperaug drainage basin and that practically no water enters the basin from deep-seated sources. Therefore except as there is increase or decrease in surface or subsurface storage within a given period the difference between the amount of precipitation in the basin during the period and the amount of stream flow out of the basin is approximately the amount that is evaporated, directly or through the agency of plants.

Natural Storage for the Water Supply.—The water that falls as rain or snow may be stored on the surface or below the surface. Surface storage includes the water that is held in the ponds and reservoirs, and for the purposes of this investigation it includes also the water in the streams. Moreover, surface storage includes the considerable quantities of water that accumulate on the surface in winter as ice or snow. The subsurface storage consists of the soil moisture, in the zone of aeration, and of the ground water, in the zone of saturation. The storage creates an interval of variable duration between the falling of the water as rain or snow and its exit from the basin by evaporation or as run-off, and it thereby greatly complicates the problem of determining what ultimately becomes of the water that falls as rain or snow.

Estimates of Run-off, Evaporation, and Underground Percolation.—The data obtained in this investigation indicate that during the three-year period the average yearly precipitation in the form of rain or snow, stated as depth of water over the drainage basin, was 44.48 in., of which 20.66 in. was carried out of the basin by the Pomperaug River, about 23.20 in. was returned to the atmosphere by the invisible processes of evaporation from soil and surface objects and of transpiration by plants, and a small balance remained in subterranean storage. It was estimated that 11.90 in. of the yearly precipitation was carried away by the Pomperaug River without ever getting into the ground, 16.99 in. was taken back into the atmosphere by evaporation and transpiration, without having percolated down to the water table, and 15.58 in. found its way to the water table and was for an indefinite period placed in subterranean storage in the zone of saturation.

Recharge and Discharge of the Subterranean Reservoir.—At the beginning of the investigation the water table was abnormally low, and hence the subterranean reservoir was not quite filled to capacity. Consequently there was a small increase in ground-water storage during the three-year period, and the average yearly discharge from the zone of saturation was slightly less than the average yearly recharge. It was estimated that an average of 8.76 in. of ground water was discharged each year by overflow of the subterranean reservoir through springs and seeps and that an average of 6.21 in. was withdrawn from the zone of saturation by the roots of plants or through the capillary pull of the dry soil and subsequent evaporation.

Mosquito Control Operations in the Chicago District

Work of Des Plaines Valley Mosquito Abatement District in 1928

The Des Plaines district includes an area of 76½ square miles and has a population of 200,000 people. Its topography, for the most part, is flat with some hilly sections. There are two polluted streams, the Des Plaines River and Salt Creek which flow through the district. In addition there are a great many small creeks, wet weather streams, woodland pools, and cat-tail swamps.

For control work the district is divided into two sections, each section being placed under the direction of a foreman with a gang of 12 laborers and one truck driver.

During the first two months of the season these gangs engaged in the drainage and clearing of mosquito breeding areas, and later, as breeding developed, were put to work oiling the marshes. In the fall when the breeding season was over the gangs again returned to drainage work.

Section Equipment.—Each section is equipped with one ¼-ton truck, used to haul men and tools. During wet weather these trucks are rigged with barrel pumps and used to spray road ditches. During the first heavy breeding two one-ton trucks were hired to haul oil to points of distribution.

Personnel.—The district employes one sanitary engineer in charge, one assistant sanitary engineer in charge of field operations, one laboratory man in charge of the laboratory, one stenographer-bookkeeper, one river inspector, one motorcycle operator, seven house-to-house inspectors, 4 field inspectors, 2 foremen, 3 truck drivers, 1 chief inspector, 24 to 36 laborers.

The report of the district for 1928 has been issued recently and from it we have extracted the notes that follow:

Mosquito Breeding Areas.—"Consideration of permanent improvements such as will eliminate mosquito breeding areas, leads us to inquire as to what constitutes mosquito breeding areas.

"It is common knowledge that mosquitoes must have water in which to breed, but even so, not all water surfaces are inviting to mosquitoes for breeding purposes and even that portion which is chosen is given to the production of only one or several species at the time.

"The most troublesome species of the domestic group flourish in dry season when rivers and streams become polluted; woodland mosquitoes prefer the comparatively clear woodland water of woodland pools, while the predominating species of the marsh group prefer the shallow warm waters of prairie marshes and field pools. Thus it is evident that temperature and food supply of the water may control the type of breeding or change it from domestic in dry weather to marsh in wet weather, even in the same river, stream, pool or marsh. Hard rains may flush an embryonic crop of domestic mosquitoes down stream, and at the same time flood contiguous bottom lands, and hatch millions of dormant eggs of a different species.

"The percentage of the total water surface constituting potential breeding areas, varies in direct proportion to the extent of its grassy covering and the shallowness of the water. In prairies, 85 per cent of all water surfaces may be considered potential areas, whereas in the deeper and fast moving water of the rivers and streams only 40 per cent of the water surface may be considered potential breeding areas."

In the Des Plaines district the total potential breeding area in rivers, streams and prairies at the beginning of the season of 1928 was 514 acres with normal rainfall. "Approximately 75 per cent of this acreage can be eliminated by drainage and from diking and filling at an **estimated cost of** $138,233." The area remaining at the completion of such a program would be 90 acres at normal rainfall, which would be increased to 243 acres with excessive rainfall.

"Comparison of the actual acreage oiled during 1928, with that necessary to be oiled after completion of the proposed program, would indicate that mosquito production can be controlled following excessive rainfall as the acreage necessary to be oiled would be a limited amount of river and stream edges in dry weather, and a reasonable amount of field pools, wet roads and edges of overflowed areas of all rivers and streams."

Policy.—"If the total revenue of the district ($60,000 annually) were devoted solely to drainage work, it would require at least four years to accomplish the desired end. In this event annoyance from the marsh and woodland groups would be reduced each year but practically no reduction could be made in the numbers of domestic mosquitoes. On the other hand if 10 to 20 per cent of the annual revenue were set aside for permanent improvements, a well rounded program could be carried out during which time annoyance from domestic mosquitoes could be abated and only during exceptionally wet spells would the marsh mosquitoes be a menace to comfort and then only out-of-doors.

Oiling Program.—"The experience of attempting to control marsh mosquitoes (Aedes vexans) by oiling, following excessive rainfall indicates the need for eliminating large marshes, woodland pools in the prairie sections and the channeling of streams to prevent flooding of bottom lands, as the eggs of this species lie dormant from the Summer of one year until the warm rainfall of the following year. **Elimination of the large breeding areas will make it possible to organize an oiling force which can cope with the problem of lots and road ditches and wet weather prairie pools and at the same time be large enough to control mosquitoes of the domestic group during dry weather and following normal rainfall.**

"Furthermore, it indicates that in order to meet a peak load, either a large force, trained in the use of knapsack sprayers, or a comparatively smaller force trained in the use of power sprayers, must be maintained ready for the emergency."

During 1928 a total of 1717 acres were oiled at a total cost of $12,673.81. The average time required to oil an acre for the season was 8.6 hours. The average number of gallons of oil used per acre for the season was 34 gal. The average cost per acre for the season was $7.40.

Inspection of Premises.—"House-to-house inspection for the purpose of eradicating domestic mosquitoes ranks next in importance to control of breeding in polluted rivers, streams and marshes. Mosquitoes of this type enter houses, although only a very few may cause great annoyance. It follows, therefore, that if breeding is permitted to continue unabated, mosquitoes dispersing from these small areas on one or several premises in each block may destroy the morale of the whole undertaking."

Street Catch Basins.—The street catch basin is a recognized source of mosquito breeding. It produces mosquitoes of the domestic group.

The number of mosquitoes bred in catch basins over a limited area never exceeds the number produced in polluted rivers, streams or large marshes. On the other hand the number bred in catch basins often exceeds the number bred in artificial containers on home premises. However, in the catch basin, breeding is more or less constant, while home premise breeding varies both as to neighborhood and number of po-

tential breeding places present at any one time.

The control of catch basin breeding is very necessary in that production here may be the principal source of annoyance especially in the high class residential districts from which the District receives its best co-operation. There are 20,000 catch basins in the 30 square miles of built-up area in the district. The cost per treatment with oil or mosquito repellent for the season averaged 2½ cents per catch basin.

Nineteen different species of mosquitoes were caught in the district during 1928; however, only 4 different species made up 98 per cent of the total number caught. Eighty per cent were "Aedes vexans, 12 per cent Culex salinarius, 4½ per cent Aedes trivittatus and 1.2 per cent Culex pipiens." The two varieties of Aedes making up 84½ per cent of the total are marsh mosquitoes, while the two varieties of Culex making up 13.2 per cent are domestic mosquitoes which breed in polluted water.

During 1928 $53,455 were spent in permanent improvements such as drainage operations, while $53,073 were spent in operating cost.

Remedying Troublesome Conditions in Filter

Method of Removing Hard Spots, Cracks and Mud Balls

By R. W. FITZGERALD
Superintendent Water Purification, Alexandria, Va.

IN THE water purification process much depends upon the efficient operation of the filter beds. Many difficulties are encountered but probably the most common ones are hard spots, cracks and mud-balls.

Causes of Troubles.—There are many agencies which contribute to the formation of these troublesome conditions. Improper coagulation causes the water to enter the filter unit with insufficient "floc" to form a good filter mat. This allows the fine particles of silt and mud to penetrate deeply into the sand bed. Insufficient sedimentation causes the filter to receive an over-load of turbidity and bacteria. In all probability bacterial growths in the filter help in the formation of hard spots. The same is no doubt true of algae growths. Broken or clogged strainers and underdrains serve as hindrances to proper washing of the filter. Washing filters at low velocities and for short periods of time encourages the formation of mud-balls. Cracks and fissures in the filter bed are usually caused either by improper washing or by the growth of certain bacteria which cause the filter mat to contract and break.

Effect of Hard Spots.—The effect of both hard spots and mud-balls is, first, to decrease the time of service of the unit in as much as they decrease the filtering area. Secondly, they form a hazard to the quality of the effluent in that they may serve as breeding places for bacteria or by forcing the water to pass too rapidly through the remaining parts of the filter. Cracks or fissures on the other hand let the water through the filter more rapidly but in so doing they lower the efficiency of the unit by allowing turbidity and bacteria to pass through also.

Results from Combination of Treatment.—Unfortunately there is no one remedy for these troubles. Rather, the filter plant operator must use a combination of treatments to get the desired results. The best treatment, of course, is the preventative treatment. The "floc" should be of good size in order to entrap the fine particles of silt, mud, etc. The retention time in the sedimentation basins should be sufficient to settle out a very large percentage of the suspended matrial. This, of course, will mean a very substantial reduction of the load upon the filter. Where a high bacterial load is present or where algae are found troublesome prechlorination has been found to be of considerable advantage. A good example of this is shown in the operation of the water plant at Raleigh, N. C. There hard spots and cracks in the filter mat were to a great extent eliminated by the use of prechlorination. Also at Southern Pines, N. C., the average filter service hours were nearly trebled by using chlorine in the raw water. Prechlorination has been used at Springfield, Ill., to lighten the bacterial load on the filters but no particular study was made as to the effect upon the prevention of mud-balls or hard spots. A high velocity wash is one of the best methods of keeping the filter in good condition. Some years ago considerable trouble with mud-balls was experienced at the plant at Gatun, Canal Zone. The rate of flow of the wash water was 12 in. vertical rise per minute. This rate was gradually increased until 24 in. rise per minute was attained. This increase in wash water velocity practically eliminated the mud-ball trouble. The same experience was had at Colon, Canal Zone. There the rise was changed from 18 in. per minute to 24 in. per minute, with results similar to those obtained at Gatun.

Method of Removing Hard Spots and Mud-Balls.—The most successful method of removal of hard spots is to break up the area with a pole and to give the filter long hard washes. The removal of mud-balls may be accomplished in various ways. If the filter can be put out of service and allowed to thoroughly dry out the balls will disintegrate and can easily be washed out. This method has been used at Oklahoma City when conditions permitted. The procedure is not applicable in most instances, however, due to the inability to leave the unit out of service for any great length of time. The method of removing the mud-balls by skimming them out with a long handled screen passed through the suspended sand during the wash has proven fairly satisfactory. This is the method in practice at Hannibal, Mo., and it has been used at Alexandria, Va., with considerable success. Scraping off the top layers of sand is common practice in many plants. Such practice has been highly satisfactory at Springfield, Ill. There the filters are all scraped at regular intervals. During the past several months very little trouble has been experienced from mud-balls or hard spots. This method, of course, necessitates periodic replacement of the sand removed. Another method which has been used at both Springfield, Ill., and Oklahoma City, is that of jetting the sand from one filter to another and screening out the mud-balls as it enters the second filter. This was accomplished by constructing a small wooden box into one side of which was set a 4 in. pipe leading to an adjacent filter. Directly opposite this pipe was set a fire hose carrying an inch and a quarter nozzle. The nozzle was placed about 5 in. from the pipe mouth and headed directly into it. The water being turned into the hose, sand was shoveled into the box and was carried by the water through the pipe. At the exit end of the pipe was placed a screen to catch the balls. This process was repeated in each filter unit and thus from 12 to 15 in. of sand was removed, washed and returned to the filter. This is rather a long process and is not recommended for use unless other methods fail to clean the filter.

Summary.—The chief causes of hard spots, cracks and mud-balls are: improper coagulation, insufficient sedimentation, bacterial and algae growths, and washes at low velocities and for too short periods of time.

The effects are to lower the quality of the effluent, to decrease length of filter runs, and to increase the number of washes.

Preventative treatments are: thorough coagulation and sedimentation, prechlorination, and high velocity washes. Curative treatments are: scraping, skimming, or removing and washing the sand.

Acknowledgment. — The foregoing paper was presented at the First Virginia Conference on Water Purification and Sewage Treatment, held April 25 and 26 at Richmond, Va.

Reducing Corrosion

How Staunton, Va., Treats Its New Supply

By W. F. DAY
City Manager, Staunton, Va.

FOR many years, Staunton, Va., obtained its domestic water supply from limestone springs located within the city limits. The water from this source is very hard (about 275 parts per million) and because of the possibility of pollution and of the deficient quantity of dependable flow, it was decided to seek a new source.

North River was selected as the new supply, as it provided a sufficient quantity for the estimated future consumption of the city, with little likelihood of pollution and is of a very soft quality.

The New Supply.—The location of the 125 million gallon storage dam and works in North River is about 15 miles northwest of the city, in the National Forest, the water being brought to the city through a 16 in. cast iron main, part of which is laid in a 6 ft. by 6 ft. tunnel through rock for 5700 ft.

A distribution reservoir of 3,750,000 gal. capacity, with aerators, was built two miles west of the city.

The cost of the new supply was over $800,000, and it was placed in operation in August, 1926.

About a year later we began to receive complaints of red water and iron rust particles being carried by both hot and cold water pipes into dwellings.

Sections of services and mains which were taken up for repairs showed a complete disappearance of the former carbonate lining caused by the hard water, and in its place was noticed the formation of tuberculation of the iron wherever the original protective coating or galvanizing was defective.

Treatment with Caustic Soda.—Following investigations and analyses of the water, with the cooperation and assistance of the State Board of Health, it was decided to raise the alkalinity of the water by adding sodium hydrate or caustic soda.

In January, 1928, we commenced feeding 60 lb. per day to 1,200,000 gal. of water. As it was some time, a week or more, before we could get any indication of the treatment in town, the amount was increased to 90 pounds per day.

We finally settled on 60 lb. per day, and tests taken twice daily at North River showed a pH of 6.6 to 7.2 of the raw water and 8.8 to 9.4 for the treated water. This produced a pH in the city of from 7.8 to 8.4.

The complaints became less frequent, and the cold water pipes delivered clear water, unless the circulation in the mains was very poor, and allowed the water to remain standing for some time in the pipe. The hot water still gives trouble; depending on the temperature to which it is heated, and also upon the condition of the boiler or heater; fixtures that are old or of poor quality offer less resistance to the corrosive action of the water.

The difficulty next appeared of stoppages in the services and house pipes, caused by the tuberculation restricting the flow of water. This was particularly noticed on the hills where the pressure is lower and in ½ in. pipes of inferior material that have been installed a long time.

In October, 1928, a firm of consulting engineers in Baltimore was employed to investigate the corrosion problem and recommended proper steps to reduce the trouble.

The New Treatment Plant.—The report was received in December, and recommended the construction of a treatment plant to be built at the North River works, in order to protect the supply main to the city. At this plant the water might be treated with lime, caustic soda or sodium silicate, or a combination of them, as proved most beneficial.

The plant is to consist of a concrete building 20 by 30 ft. and a double sedimentation tank 34 by 53 ft. and 11 ft. deep, all designed for the ultimate flow of 2½ m.g.d.

In the building are to be placed a solution tank, 9 ft. in diameter, an automatic feeding device, a mixing channel and storage space for chemicals. An overshot water wheel operates the agitators in the solution tank. Head for operating the water wheel is to be obtained from water behind the dam. Tail water from the wheel flows into the mixing channel

Dam on North River and Part of Reservoir, Staunton, Va.

and thus would not be wasted. This plant is estimated to cost $14,000.

Plant Operation.—The plant is being built about 100 feet from the dam, and will operate as follows: a valve in the supply main will divert the water through a mixing channel in the chemical house, where a pre-determined amount of lime solution will be thoroughly mixed with the water.

The dosed water then flows quietly through a sedimentation basin of an hour's capacity, during which time inert chemicals and sludge settle out, the clear water in the meantime flowing continuously to the city. The water wheel is used to stir the lime or other solution in the solution tank, so that uniform strength of chemical is maintained.

The sedimentation tank is divided so that in cleaning it would not be entirely out of operation. This tank is covered with a concrete roof to prevent freezing or the admission of leaves and other trash.

Once a day the caretaker at the dam will put a weighed amount of chemical into the solution tank, filling it up with water and then inspecting the working parts, such as the water wheel, automatic measuring device, etc.

Removing Corrosion from Service.—This treatment plant is intended to reduce the future corrosion of the distribution system and house pipes, but will not remove the corrosion and stoppage of the services now existing.

This is another problem. We have been experimenting with several methods of doing this, and we have found that a 10 per cent solution of sulphuric acid, if left in a corroded service line for 4 or 5 hours, will loosen the tuberculation and by blowing compressed air through the line it will be fairly well cleared. Care has to be taken not to leave the acid in the pipe too long, for not only will the corrosion be loosened, but holes will be eaten in the pipe as well. Of course we are careful to neutralize the acid left in the line before turning the water back in the house.

We recently have tried with good results the removal of the corrosion by introducing dry steam into the service line, and as the pipe expands faster than the corrosion attached to it, the corrosion is loosened and may be washed from the line.

The treatment plant at North River is being built by city forces, and we expect to have it completed and in operation by August 1st.

Acknowledgment.—The foregoing is a paper presented April 26 at the First Virginia Conference on Water Purification and Sewage Treatment.

Traffic Engineers.—Twelve cities and one county now have traffic engineers.

Method of Testing Soil for Westfield Dam

Soil tests in connection with the construction of the Granville earth dam for the city of Westfield, Mass., were facilitated by the use, in the field office, of a device for measuring the capillary rise of water in the samples of soil. The method involving the use of this device was worked out by Dr. Charles Terzaghi of Massachusetts Institute of Technology.

The device, which is illustrated in the accompanying drawing, consists of a small tank to hold water and support a set of capillary tubes, an irrigator tank and a set of tubes. In making a test, the sample of earth is first dried, care being taken not to burn the material. The tubes are filled with the dry material in layers and compacted. They are then set into the tank and water from the irrigator tank is fed to the tank containing the tubes. The dam at the end of the tank holds the water to a level which will keep the bottom of the tubes always submerged. The tubes are graduated, or a scale is erected in back of them. The time is taken when the tubes are first set in the water and, as the water rises in the soil, readings are taken every five minutes. These readings are plotted on a diagram which gives the relation of the capillary rise of water in the soil to the coefficient of permeability.

Numerous tests were conducted previous to construction. The weight and volume of each sample tested are measured. Knowing the specific gravity of the material, the volume of voids and the void ratio are readily computed. While the theory underlying the process is rather involved, the application of it is very simple. Taking a set of samples, testing and recording the results requires the time of only one man about one-quarter of a day. The suitability of a material for use in the fill can be determined within an hour.

Automatic Device Prevents Freezing in Pipes

A device to prevent the freezing of water in pipes, not dependent upon thermostatic action, has been exhibited recently. A brass freezing chamber is employed to spread the stream of water into a thin sheet which is frozen at a temperature 10 degrees higher than that which would congeal the water in the pipes. In freezing, the thin sheet of ice exerts pressure against a metal diaphragm which opens a drain valve and empties the pipes of water. With the advent of milder temperatures, thawing of the ice releases pressure on the diaphragm, closes the drain valve, and permits water to flow again.

Sawdust Streets Built in Lumbering Town

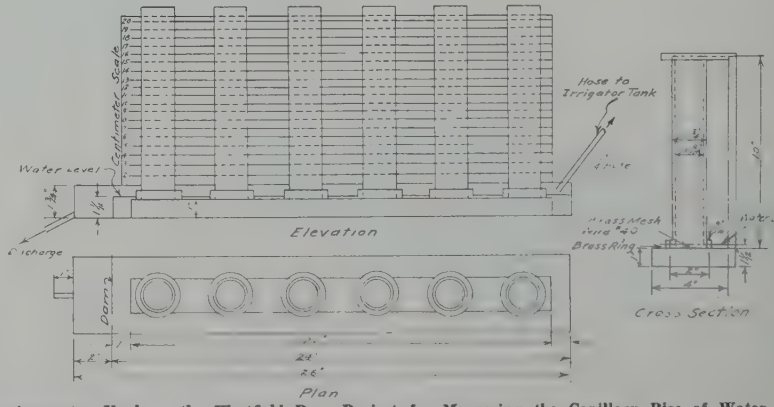
When the citizens of Dorris, Calif., a lumbering town in Siskiyou County, demanded relief from the muddy condition of the streets, sawdust was suggested as a paving material. Several tons were secured from nearby sawmills and distributed over the streets of the town. After the sawdust had packed down, it was found to give an excellent roadway surface.

Recording Meter Readings by Photography

Where tests are being run which require frequent readings of a number of instruments, or where simultaneous readings of a number of meters, etc., are required for purposes of record, it will be found convenient to assemble all of the instruments on a single board and photograph the group at the necessary intervals. Reference to the photographs will furnish any desired readings.

Drainage Yield, Wanaque Watershed

Filling of the 27,800 m.g. Wanaque reservoir of the North Jersey District Water Supply Commission in less than a year gives a daily average yield for the drainage area of 94.4 sq. mi. tributary to the reservoir of 1.1 m.g. per square mile of drainage area.



Apparatus Used on the Westfield Dam Project for Measuring the Capillary Rise of Water in Samples of Soil

Control of "Unaccounted-For" Water

Results of Tests and Studies in a Number of Cities

By W. C. MABEE
Chief Engineer, Indianapolis Water Co., Indianapolis, Ind.

UNACCOUNTED-FOR water is defined by the Water Works Practice Manual as "that portion of the water flowing into a distribution system which is not delivered to the consumer." Water waste is defined as "water which is not drawn to serve effectively a useful and legitimate purpose."

Confusion in Classification.—There is often confusion as to the meaning of the term "unaccounted-for water," as will readily be discovered by studying the answers received to the questionnaire sent out by the Indianapolis Water Co.

There is a tendency to group water allotted to public uses, such as fire fighting, flushing streets, sewers, unmetered services, under-registration of meters and underground leakage into a lump and call that unaccounted-for water. Much of this so-called unaccounted-for water is delivered to the consumer and is, therefore, in the language of the definition before quoted accounted for, having served effectively a legitimate purpose.

Water waste is another matter and it may or may not have been measured to the consumer.

If Indianapolis, for instance, were to report its unaccounted-for water as embracing water not metered but used for public purposes, plus leakage and unauthorized use the report would read 18 per cent of its total pumpage; whereas, if a reasonable allotment of legitimate use to public and other known uses is made, confining the answer to the definition above given; that is water not delivered to the consumer, the percentage is 10.7, approximately.

It seems, therefore, that water that can reasonably be accounted for as having been used by the consumer, whether it be the fire department, public street sprinkling, flushing of sewers, water for swimming pools, public parks and municipal buildings or other legitimate purposes, is not unaccounted-for water although frequently classified as such.

No water works system can reasonably be expected to account for all the water that enters its distribution mains. There are unavoidable losses due to underground leaks that it would not pay to uncover and repair, under-registration of meters that in some instances would cost more to keep operating at an efficiency of 100 per cent than the value of the water saved would be worth. There is an economical efficiency beyond which there would be no profit.

On the other hand there are large losses in underground leaks, under-registration of meters and unauthorized uses that could very profitably be recovered. Some of these losses which have recently come to my attention I will touch upon later.

The Economic Limit.—An occasional check up should be made for unaccounted-for water to keep it within bounds.

Unaccounted-for water that exceeds an economic limit is an economic waste; the money value of which will depend upon local considerations, but which will in most instances represent a substantial loss of revenue.

Water that has been purified and pumped represents invested capital in plant, in operation, in materials, in supplies and in maintenance. This represents its value and it should be conserved as other commodities are conserved.

If, by means of water waste surveys, water prevention, more accurate meter measurements, or other means of decreasing consumption without restricting legitimate use, a saying can be effected, that conservation of the water supply means deferring the time when additional supply will have to be provided involving a corresponding outlay for boilers, pumps and buildings.

By the term "economic limit" in implied in the language of E. K. Wilson, chief engineer of the Pitometer Co., in referring to unaccounted-for water and under-registration of meters "that point beyond frequent testing brings in returns less than the cost of the work; probably 85 per cent would be a fair figure."

E. D. Case, vice-president and general manager of the same company, commenting on this same subject in a recent letter to the writer, says: "It is my opinion that every metered city should account for at least 85 per cent of the total consumption, and it is possible by present up-to-date methods to increase this figure to the economical limit."

There is, of course, no hard and fast rule that will apply to all communities alike, and the economic limit in one place would be a different figure in another, depending on local conditions.

Separation of Consumption.—For years engineers have been advocating a separation of consumption into at least two divisions; one being industrial and the other domestic. More divisions are preferable, but these two are indispensable if we are to compare consumption figures, however, having acquired the habit of reporting consumption per capita as one figure without reference to the industrial consumption, we go on reporting consumption in this unscientific manner.

We had occasion recently to study the distribution of water in Indianapolis, where we are about 50 per cent metered with reference to ascertaining the amount of unaccounted-for water that we were pumping into the system and which at first glance seemed to be a large part of our pumpage. As a preliminary step in making this study we decided to compare our consumption of water with other cities and to that end sent out a questionnaire to several hundred cities, large and small, and widely separated.

These answers have been tabulated and show these data in a condensed form, arranged alphabetically by groups according to population, which is made part of this paper.

Analysis of Pumpage at Indianapolis.—The next step was to analyze our pumpage by subdividing it into five groups as follows:

(1) Industrial, (2) Commercial, (3) Domestic, (4) Public and (5) Unaccounted for; tabulating the annual and daily consumption in million gallons and reducing these to gallons per capita per day and to per cent of total pumpage.

The service was itemized as follows:

First — Industrial Use. — Industrial service included railroads, factories, utilities, manufacturing plants, dairies, ice plants, laundries, etc.

Second — Commercial Use.—Stores, offices, clubs, hotels, office buildings, hospitals, schools, colleges, theatres, churches, barber shops, garages, etc.

Third—Domestic Use.—Apartments and residences.

Fourth — Public Use. — Municipal buildings, parks, play grounds, swimming pools, fire protection, fountains, parkway sprinklers, building construction, flushing streets, sewers, water mains and ditches.

Fifth—Unaccounted-for Water.—Unavoidable leakage in mains and services, unauthorized use of water, extraordinary meter slip and water otherwise unaccounted for.

A minimum allowance for under-registration of meters was made for each division where service was metered.

Considering the questionnaire so far

as Indianapolis is concerned our studies disclose the following:

Daily per capita consumption	89.3 gal.
Average daily pumpage	34.83 M.G.D.
Percentage of pumpage registered on customers' meters	56%
Per cent of all services metered	45.8%
Per cent of all domestic services metered	41%
Per cent of industrial and commercial services metered	96½%
Per cent of pumpage unaccounted for	10.7%
If underground leakage and unauthorized water only is considered.	
If unmetered public uses, under-registration of meters, underground leakage and unauthorized uses are combined	18%
Under-registration of meters assumed as about	5%
Frequency of meter testing; at least every six years for small meters, yearly for large meters.	
Have studies of unaccounted-for water been made?	Yes.

These studies disclosed the percentage given, which from an inspection of the tabulation does not appear to be an unusual quantity of unaccounted-for water. No steps have been taken to decrease the amount of unaccounted-for water as yet.

Comparison of Consumption.—Statistics are apt to be misleading unless all of the facts and conditions are known.

To arrive at a comparable comparison the industrial and commercial uses must be excluded from the total, because of the wide variation in industrial use of water in the different cities. The remaining consumption represents public use, domestic use and unaccounted-for leakage or other loss.

In Table I we have been unable to check up average daily pumpage and per capita consumption with population figures in many instances, and have observed a lack of standard practice in the matter of reporting under-registration of meters and in unaccounted-for water.

In general, I believe that most water works superintendents consider unaccounted-for water the difference between the quantity of water metered to consumers and the quantity entering the distribution system. Unaccounted-for water may be classified in the following divisions:

First: Pump slip.
Second: Underground leakage.
Third : Unauthorized use.
Fourth: Under-registration of meters.

Pump Slip.—It has frequently been found that, in the absence of a master meter, the plunger displacement of reciprocating pumps has been taken as the measure of water entering the distribution system the quantity has been grossly exaggerated. Instances have been known where the discharge from a pump has been completely closed and the pump has gone on churning.

Allowances for pump slip are sometimes taken as low as 2 per cent, usually as 4 or 5 per cent and it is not unusual to find upon careful tests that pump slip may far exceed 5 per cent and may be as much as 30 per cent of the theoretical displacement of the pump plungers.

So that in considering data presented, allowance must be made for the source of the information and the judgment of the person supplying it.

Underground Leakage.—Underground leakage usually represents the largest element of unaccounted-for water. It occurs at pipe joints, service connections, broken pipe or broken services, at blow-off connections or in valves. It is caused by poor workmanship in making joints when pipe was laid or has developed from settlement, or injury occurring after pipe was laid and is not infrequently due to electrolysis, sometimes caused by the corrosiveness of the soil and often caused by stray electric currents leaving the metal structure.

While it is possible to make pipe joints absolutely tight, a certain amount of underground leakage is considered unavoidable. Engineers often specify a tolerance of 200 or 300 gal. per inch diameter per mile of pipe in 24 hours in new systems. The Pitometer Co. considers 3,000 gal. per mile of pipe per day a reasonable allowance for unavoidable underground leakage, after all reasonable precautions have been taken to stop leaks.

There are many water systems, no doubt, that have been fortunate enough to keep underground leakage below this allowance, but there are many more that are not so fortunate. For instance:

The City of Chicago in 1926 tested 66 miles of mains in advance of street paving, and found underground leakage of 10,000 gal. per day per mile; 90 per cent of which was stopped.

The City of Philadelphia, now conducting a pitometer survey for water waste, found underground leakage on a section embracing 626 miles of pipe, amounting to 10,250,000 gal. per day, or in excess of 16,000 gal. per mile of pipe per day, which will, as a result of this survey, be reduced to a minimum.

During the past eleven years Chicago has discovered underground leakage on 668 miles of pipe, which has averaged about 13,000 gal. per day per mile of pipe.

The City of Cincinnati, in 1925 and 1926, found and stopped leakage amounting to 5,000,000 gal. per day, or 10 per cent of their total pumpage. The survey covered about 800 miles of mains which is equivalent to 6,250 gal. per day per mile of pipe.

The City of Detroit located and stopped leakage in mains and service as a result of a pitometer survey in 1919 and 1922 amounting to 9,500,000 gal. per day over 1,151 miles of mains, which is equivalent to 8,300 gal. per day per mile, since which time the City of Detroit has organized its own pitometer department and carry on continuously.

Underground leakage such as that just described was interceptible on the surface; the leaks were of such a character that the water was readily dissipated into the soil or into the nearest sewer without a showing on the surface. One superintendent wrote in that he was able to discover leaks by observing after a snow storm the wet places in the snow and would mark the spots for future attention. Others inspected sewers periodically to discover abnormal flows which would indicate leaks or excessive waste.

Underground leaks, beginning in a small way, may, after the lapse of time assume substantial size and cause considerable damage by undermining pavement. A break in a water main may exist and continue for an indefinite period, discharging into a sewer manhole and may never be discovered unless a search is made for just such a condition.

Too often service pipes are installed in the same trench, as the house sewer. This is an invitation for trouble, as a leak may occur on the service pipe and the water escape into the sewer without detection.

The aquaphone, or listening device, is often employed to locate leaks. It is often difficult to detect underground leaks by this method in a large city, because of the noise of the busy street. Blow-off connections into streams or sewers may have been left open. Stuffing boxes of valves are frequently found leaking and in many cases are difficult to prevent. The kind of packing used has a large influence on leaks of this character.

Submarine leaks can be discovered by forcing compressed air into the pipe and observing bubbles on the surface.

Longer lengths of pipe are now being advocated to reduce the number of joints and consequently the quantity of leakage; one-third of the joint leakage can be prevented by the use of pipe in 18-ft. lengths.

Results in Various Cities.—One of the most enlightening answers to the questionnaire came from the city of Akron, O., which is 100 per cent metered, where the water department has evidently been studying this question of "unaccounted-for flow" for the past seven years. The percentage of un-

Table I—Composite Water Consumption of Cities Responding to Questionnaire

Number of cities	Total population of cities	Per capita consumption per day gallons	Per cent of pumpage or supply entering distribution mains registered by individual meters	Water alloted to Unmetered Public Use Underground leakage, Under-registration of meters, Unauthorized use or otherwise unaccounted for
160	25,394,427	98.67	.....	.....
123	.....	.....	71.68	.....
121	.....	.....	.....	24.72

Average 158,715.

accounted-for flow for this period averaged 23 per cent, but during the last four months of 1927 had been reduced to 12 per cent of the total pumpage. This reduction was brought about by "conducting a continuous street survey covering hydrant, valve, curb cock, sill cock, and general surface inspection."

Unaccounted-for flow in Akron "includes illegal use of water, leakage, street flushing, testing, sewer flushing, water main flushing, construction, fire fighting and meter under-registration. In Akron practically all new mains are laid by water works force account. "Construction specifications have been changed to require new mains to pass a leakage test of less than 100 gal. per inch-mile per 24 hours."

"Results obtained average less than 30 gal. per inch-mile per 24 hours before actual acceptance." Here, then, is a shining example for the water works fraternity to emulate.

Baltimore, with 19 per cent of its domestic accounts and 100 per cent of its industrial and commercial accounts metered reports 18.4 per cent unaccounted for and allots 8 per cent of this to municipal use and 10.4 per cent to waste (leakage?).

Chicago has a daily per capita consumption of 292.5 gal. and records 31.4 per cent through individual meters, which supply 16.1 per cent of the services. The city engineer reports 10 per cent of the pumpage chargeable to underground leaks, pump slip, etc., and about seven per cent of this to underground leakage.

Cincinnati, which meters all revenue-producing consumption, accounts for 75½ per cent of the total. Water used for fire protection, street cleaning, public buildings, parks, etc., is not metered.

Cleveland, which is 100 per cent metered, accounts for 75½ per cent through meters.

Kansas City, Mo., which is 84.6 per cent metered, accounts for 75 per cent of its pumpage through meters, estimates free water at 12 per cent, waste, leakage and under-registration of meters 10.1 per cent and flat rate domestic 2.9 per cent.

New Orleans delivers 47.9 mgd into its distribution system (110 gal. per capita per day), of which 68 per cent is recorded through consumers' meters. All of the domestic accounts are metered and all of the industrial and commercial accounts except fire-sprinkler connections.

New York City has a daily per capita consumption of 144 gal., uses 867 mgd. and records 26 per cent through individual meters. Three per cent of the domestic accounts are metered and 21 per cent of industrial and commercial. Forty-two per cent of total municipal supply to city is considered unaccounted-for flow and is defined as follows:

"Leakage from plumbing fixtures of domestic consumers and free users is estimated to be 25 per cent of total supply to city; meter slippage 6 per cent of total supply; underground leakage from water mains and service pipes 11 per cent of total supply."

The following comment is made respecting efforts to check water waste:

"House to house inspections have been made to stop leakage from plumbing fixtures as temporary expedients to conserve supply during time of shortage of water. The saving made during such inspections is lost in about two years' time. Underground waste work has been carried on for a number of years with excellent results, but the size of the force engaged in this work has been too small to cover the city in a systematic manner."

Washington, D. C., reports having located and stopped underground leakage amounting to 40 million gallons daily, the daily per capita consumption is now 137 gal. and the total consumption 68.7 mgd., of which 44.2 mgd. is recorded through individual meters; 85 per cent of all water services being metered. No record of unaccounted-for water is kept, due to unmetered use by federal and district government.

Unauthorized Use of Water.—There have been instances where water has been taken from fire-sprinkling connections, from services and from mains and not paid for until discovered by the sleuths of the water department. Sometimes this illegal use of water is unintentional, accidental perhaps, but no such user of unauthorized water will admit that water was taken with malice aforethought.

The illegal use of water is not a recent practice. It was known and practiced in Rome several thousand years ago.

Under-Registration of Meters.—There is considerable difference of opinion touching the subject of unaccounted-for water as affected by under-registration of meters and it is hardly to be expected that there would be an agreement on this subject since the conditions surrounding the standard practice of different communities respecting meters vary so widely.

There is need for standard practice rules and regulations governing meter testing inasmuch as the accuracy of meters affects "Unaccounted-for Water." Some cities have adopted definite testing schedules. Many cities remove and test meters when they stop functioning or when there is a suspicion that the meter is not properly recording flow or when "marked variations occur," "ten years on the average," "when they stop." In general the period set for testing meters, where a rule is followed, appears to be five years. This average was obtained from information supplied by large number of cities which had been circularized.

Acknowledgment.—The above is an abstract of a paper presented at the annual convention of the Indiana section of the American Water Works Association.

Municipal Uses of Water at Springfield, Mass.

The following table from the 55th annual report of the water commissioners of Springfield, Mass., shows the municipal uses of water in that city in 1928. The amounts and quantities shown are for mean year periods. Unmetered quantities in gallons are estimated from amounts, on basis of 6 2/3 ct. per 1,000 gal.—or equivalent of 5 ct. per 100 cu. ft.

Classification	Amounts	Gallons	
*Schools	$ 7,834.70	117,088,100	
*Public buildings (not schools)	4,040.55	60,450,500	
*Public Parks	2,694.40	40,310,900	
*Public playgrounds	466.28	7,921,500	
†Building purposes (streets and engineering department)	477.25	7,158,700	
†Sewer department (flushing)	4,114.03	61,710,500	
*Snow removal (via sewers)	1,232.51	18,487,700	
†Street washing and sprinkling	2,363.15	35,447,300	
†Drinking purposes (for animals)	60.00	897,700	
Total of above	$23,282.87	349,472,900	
Fire hydrant service	61,750.00‡	At $25 per hydrant	
Total municipal use	$85,032.87	(as per registrar's report)	

*All metered. †Unmetered. ‡Not reducible to quantities.

The water commissioners comment as follows on the above figures:

"The foregoing total amount of $85,-032.87 represents a portion of the accrued earnings of the water-works public service enterprise (but at low values) just as much as do the revenues charged to and collected from all private consumers. For proper accounting purposes this amount has to be charged annually to the municipality on the books of the water-works and then charged off as uncollectible, because payment therefor is prohibited by city ordinance."

Progress of the City Manager Plan.—The city manager plan is now in effect in a total of 383 cities in this country, and in 16 cities of Canada. Michigan leads all states in the number of cities under the plan, having 44; Florida follows with 39, California with 33, Texas with 31, and Virginia with 25. Ohio, while having only 19 cities under the plan, has the largest number of people living under this form of government by virtue of its larger cities under this form of government.

Trickling Filter Dosing

A Simple Dosing Apparatus

CONSIDERABLE trouble is experienced in dosing small experimental trickling filters at definite rates and in securing even fairly uniform discharge over the filter area. With a smaller area than served by one nozzle in a large plant it is desirable to reduce the rate of flow through a nozzle, and this adds to other troubles encountered. A simple apparatus that gave satisfactory results is described as follows in Bulletin No. 26 of the Illinois State Water Survey by G. C. Habermeyer and H. L. White.

The apparatus is shown in the sketch. Sewage is pumped into a half barrel placed several feet above the surface of the filter. From this half barrel a short pipe carries sewage to a dosing tank, the top of which is about level with the bottom of the barrel. An overflow pipe is connected through the bottom of the half barrel. By changing nipples on the top of the overflow pipe, the sewage level can be held at any desired elevation, so as to give any desired rate of flow into the dosing tank. It was necessary to clean the short pipe from the half barrel with a test tube brush, daily.

Sewage flows from the dosing tank to the filter through a siphon, a vertical pipe, a trap, and a pipe with a slight slope upward to the nozzle. Siphons and traps of small pipe, with siphon auxiliaries, were tried and discarded. A bell consisting of a 4-in. pipe cap is now used on the siphon.

One auxiliary that was tried with the pipe siphons and also with the bell was a trap of ¼-in. pipe attached to the top of the siphon. This trap was nearly as deep as the main trap and was filled by the sewage flowing into the dosing tank. It was expected that this would give sharp start and stop to the siphon and greatly reduce the quantity of air discharged through the main trap to the filter and thus give more uniform discharge. Results secured with this very small auxiliary were not satisfactory, and it was discarded.

The auxiliary now used consists of a trap of ¼-in. pipe screwed into the side of the bell of the siphon. A detail of the trap and bell is shown in Fig. 1. When the sewage level goes below the top of the outlet pipe while the tank is discharging, sewage is siphoned under the bell until enough air is drawn in to break the siphon. The auxiliary trap is placed at such an elevation that the sewage is drawn from it by the suction created by the siphon, just before air is drawn below the bottom of the bell. The siphon breaks sharply, since the ¼-in. pipe admits air into the bell after the bottom of the bell has been covered by incoming sewage. When the auxiliary trap is not used, the bottom of the bell is covered—by the sewage coming and the sewage falling from inside the bell—before the bell is completely filled with air, and the siphon does not break sharply.

In order that, with the dosing tank nearly empty, sewage could be sprayed onto the central part of the filter at a rate less than the average rate of inflow into the dosing tank, a throttling valve was placed against the end of the inlet pipe into the dosing tank. The valve was operated by a float in the dosing tank as shown in Fig. 1. A wire from the float passed up over a pulley and then down to the valve. As the sewage level lowered when the tank was dosing, the float gradually closed the valve. This reduced the rate of inflow sufficiently to permit the siphon under the bell to break. The valve seat was made uneven purposely, so that a small stream of sewage flowed from the pipe even when the valve was closed. This allowed sewage to flow into the tank when the dosing period was over, thus raising the sewage level sufficiently to open the valve and fill the tank again. This throttling device was discarded because clogging prevented uniform operation, because it was difficult to determine the amount of sewage applied to the filter, because the long time the valve was held nearly closed gave a long time between doses to the filter, and because it was found that the lowest rate of flow from the dosing tank through the nozzle was greater than the average rate of inflow, so that throttling the inflow was not necessary.

A dosing tank was then designed after some preliminary experiments with a barrel. In the preliminary experiments the relation between the elevation of the water level in the barrel above the nozzle, or the head on the nozzle, the rate of discharge, and the distance from the nozzle to the area that was being sprayed, were obtained. Nozzles used in the first tests discharged at a higher rate than desired. The capacity of a Worcester nozzle was then reduced by fastening over the orifice a brass disc with a small circular opening. The nozzle clogged on the first discharge but seldom clogged thereafter. With a nozzle chosen, the proper elevation of the top of a dosing tank to spray to the outer edge of the filter, the elevation of the bottom of the tank to spray close to the center of the filter, and the shape of the tank, were determined. For convenience in making these determinations, radii of the filter were divided into fourths and marked with nails. Water levels in the dosing tank were marked when the spray was to the outer edge of the filter, to three-fourths the radius, to half the radius, and to one-quarter the radius. The relative filter areas between the points marked on the radii were seven, five, three, and one; and, with due allowance for the constant inflow to the dosing tank, this gave the proper relative capacity of the parts of the dosing tank between the marked points. The relative areas, expressed in percentage of the total, were 44, 31, 19, and 6; and the percentage of the total sewage applied to these areas, with the tank designed and with all connecting pipe clean, during two tests, averaged 55, 36, 9, and 0, respectively. The outer 75 per cent of the area was dosed higher than the average. Much of the remainder of the spray fell at a little less than half the radius from the center, giving about 10 per cent of the area sprayed at about normal rate.

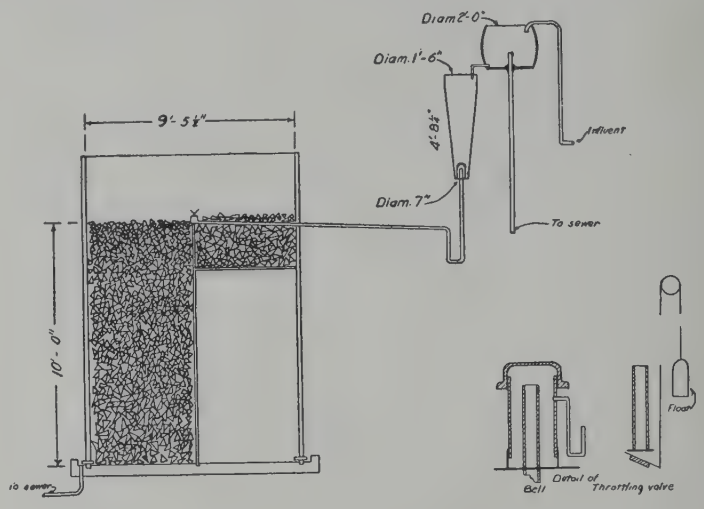


Fig. 1—Details of Dosing Apparatus

As the pipe became dirty the spray fell a little nearer the center and average conditions were better than during any one test. It was considered advisable to have little sewage fall on the inner 6 per cent of the area, as it would fall on or close to partition walls in the filter and flow down the walls.

The sprinkling filter was started on Nov. 30, 1926. Its area was .0016 acres. During the first month of operation the rate was slightly low, and stops were more frequent than later, giving a net rate of 1,800,000 gal. per acre per day. This was increased the next month (January) to 1,900,000 gal. per acre per day; and from that time until Sept. 15, 1927, excepting for a shut down of about 67 hours due to flooding the experiment station by an adjacent stream, the quantity filtered gave a net rate of practically 2,000,000 gal. per acre per day.

Lengths of Filter Runs

Operating Data for Fredericksburg, Va. Filter Plant

By R. J. LEVEQUE
Superintendent of Filtration, Fredericksburg, Va.

THE figures which appear in the space on the operating report devoted to filter runs, always serve as interesting material for study, since these figures are very often indicative of the efficiency with which the plant is being operated, assuming of course that conditions governing any particular plant are known.

The Fredericksburg plant is not quite two years old. Putting the new plant into operation meant that the usual experimental stage would have to be gone through, records kept and data compiled to serve as reference material and operating guides for the future. When records of these runs are compared, they show on the average a steady gain.

How Improvement Was Effected.—This improvement might be attributed to several things but I think that the greatest factors for this increase were the substitution of soda-ash for lime the changing of the point of application of chemicals to the raw water, the latter being the more important.

Formerly the chemical feed pipes injected the coagulants into a T on the discharge side of the low service pumps. This T was located closer to the discharge into the left basin than it was to the right basin. With both basins being supplied by this raw water line, it naturally followed that the left basin being nearer the point of application, received the bulk of the applied water. The water going to the other basin as a result was undertreated. It was impossible to get an even distribution, consequently proper settling could not take place. This increased my filter loads and shortened my runs considerably.

The coagulants are now applied 15 ft. ahead of the raw water pumps. The results are nothing short of marvelous. A thorough mix is obtained in passing through the pumps and into a pair of splendid mixing chambers of the "around the end type." Both basins are now equalized in the amount of treated water received and we are now able to utilize and reap the benefits from our rated settling period.

Importance of Jar Test.—With this handicap removed, I have been able to lengthen my filter runs still further by devoting much time and attention to the "floc." As good filter performance is greatly dependent on the condition of the floc, I would like to stress the importance of the jar test, especially to the operator of the small plant. It eliminates guesswork. Very often a floc will look good in the basins, and, yet many times it is possible to obtain a still better one. Dipping up a few jars of the coagulated water and changing the proportions of the chemicals makes it possible to observe and compare the results of each altered dosage. Frequently the best settling takes place in the jar to which the least amount of chemicals have been added.

In my daily tests I take a pH of the jar contents giving the best results and hold the water going to the basins at this optimum. At Fredericksburg the best coagulation seems to be effected at the range between 6.6 and 7.0.

Conditions Reducing Filter Runs.—Some valuable experience was gained last year in coping with conditions that tended to reduce filter runs. The first was algae. No growths appeared in the basins, and the raw water had a turbidity of less than 15 parts per million and the only indication that anything was wrong was a stringy floc and a pronounced grassy odor to the water. A chance walk up the canal to the dam where the water was calm, revealed the trouble. The surface was coated with a green scum. This year I was able to check this with copper sulphate at the first appearance of the stringy floc and instead of having prolonged short runs, as before under similar circumstances, this time in two days, I was able to start the filters back to normal runs.

The second condition was air-bound filters, especially noticeable in the spring and fall of the year. My gauges did not show any great loss of head and yet the filters would not pass their required amount of water. A careful check-up for leaks in the valve-stem packings, and the tightening of any that were doubtful relieved the condition somewhat, but I presumed that this condition was caused more by the sudden temperature changes in the water. My method of getting around this situation, was to close the effluents on any ailing filters for a few minutes, which permitted the air to rise to the surface. Using the re-wash after this and then putting the filter back into service did away with the necessity for washing for several hours.

Use of Re-Wash Valves.—I have a few words regarding the proper use of the re-wash valve, after a filter has been washed. Using this valve from 3 to 10 minutes at this time not only will lengthen a filter run but will also improve the quality of the effluent. I have noticed of late that a filter washed just prior to shutting down the plant for the night, gives from two to five hours longer run than those washed at any other time. The natural settling that takes place over night seems to form a splendid unbroken mat over the sand bed, which apparently, is even better than the one formed by using a slow rewash, due perhaps to the fact that no fine particles are drawn down into the bed. Of course in the larger plants, extra units make it necessary to return a filter to service immediately after washing, but I am sure that if any small plant can spare a washed filter, if only for thirty minutes before putting it back into service, thus permitting a natural formation of the mat, that their filter runs will be materially increased.

Supplementing these operations, it is of course understood that the proper care of filter beds must be undertaken and that they must be frequently probed for hard spots, cracks and dead areas, together with the inspection of the sand surface for mud balls.

Cleaning Basins.—The frequency with which a coagulating basin should be cleaned is dependent upon how much suspended matter the raw water contains, how much coagulant is used, how good the floc secured and other factors. The time for cleaning is easily observed by old "floc" being raised up from the bottom of the basin and carried over onto the filters, the appearance of gas bubbles, and by measuring the depth of the sludge. For this latter method I attached tin cans to a pole at intervals of 6 inch for a distance of 6 feet. The uppermost can containing sludge gave an approximate depth of the settled matter.

We cleaned our basins for the first time, six months after the plant had been in operation. The accumulation of sludge was so great that to wash it out by ordinary methods was deemed inadvisable for reasons which are here given.

The plant at Fredericksburg is situated in a hollow. A ditch drains this lowland, emptying below the town. This same ditch is used by us as a drain, the plant being erected directly over it, and to empty this great amount of sludge into the run, would have clogged underneath the plant.

A force of men was assigned to remove the greater portion with shovels and buckets. This proved a very laborious task and four days were required to clean both basins. On that basis, washing basins proved expensive, and so it was decided to wash them out in the future, at regular intervals of from two to three months.

This enables one man to accomplish the job in one and a half hours.

The design and construction of our

sedimentation basin at Fredericksburg makes the cleaning a short and easy operation. Due to the pronounced slope of the floor of the basin to the draining gutter, a great deal of the sludge is washed out during the draining process, which reduces considerably the amount to be washed out with the hose.

When the water was drained down to about 6 in. above the sludge we commence loosening the sludge in the farther end of the basin with the hose. By the time the draining is finished, one end of the basin is practically cleaned. As different batches of sludge are loosened by the hose, I open the connecting gate between basins, allowing water from the other basin to come in and fall over the weir, the entire width of the basin. This keeps the sludge thin, and enough water is used to carry the loosened sludge down over the whole area of the basin.

Washing more frequently has proved more economical for us and clean basins are assured at all times.

Acknowledgment.—The above paper was presented April 25 at the First Virginia Conference on Water Purification and Sewage Treatment.

Chlorinated Copperas as Coagulant

Experiences at Chickasaw, Mobile County, Alabama

By A. CLINTON DECKER and H. G. MENKE

Respectively, Sanitary Engineer, Tennessee Coal, Iron & Railroad Co. and Chickasaw Utilities Company, and Assistant Sanitary Engineer, Alabama State Board of Health.

THE Chickasaw water works system supplies water to the towns of Chickasaw, Ala., and Prichard. Chickasaw is a town built by the United States Steel Corporation during the war to provide housing facilities for the employees of the Chickasaw Shipbuilding Co., a subsidiary of the corporation, and is located about seven miles north of Mobile. The present population of Chickasaw is about 2,000. The town of Prichard is an incorporated municipality having a population of approximately 1,500. The water works plant at Chickasaw was built by the steel corporation in 1918 to supply water for domestic and industrial purposes for the village and plant.

The Water Works.—About 18 months ago, the Alabama Water Service Co., with general offices in Birmingham, secured a franchise for supplying water to the town of Prichard and negotiated a lease with the Chickasaw Utilities Co. for the operation of these properties to supply water to Chickasaw, Prichard, and adjacent territory. The plant at this time consisted of a pumping station, plain sedimentation basins of 1,000,000 gal. capacity, an elevated steel storage tank of 200,000 gal. capacity, and a very complete distribution system. The source of supply for this plant was Eight Mile Creek which originates in springs and flows through heavily cypress wooded territory. The water has a color ranging from 40 to 130 parts per million; the turbidity normally varies from 3 to 25 parts per million and on very rare occasions reaches 50 parts per million; the alkalinity ranges from 2 to 5 parts per million; and the pH ranges from 5.5 to 5.9. The bacterial count is usually low —mostly under 100 per cubic centimeter. In the original plant, provision was made for chlorinating the water as it was drawn from the settling basins and pumped to the elevated storage tank.

The filtration plant is an entirely new unit of the Water Works System at Chickasaw. The construction of this unit was begun the first week in January of this year and completed April 6th.

Because of the possibilities which preliminary studies had indicated as being presented at this plant for successful use of "chlorinated-copperas" as a coagulant, the authors invited L. H. Enslow, of the Chlorine Institute, who had first suggested the use of this coagulant at Chickasaw; C. Arthur Brown, Chief Engineer, Bureau of Water Purification, American Steel and Wire Co.; C. P. Rather, Chief Engineer of the Alabama Water Service Co.; and G. R. Kavanagh of the Wallace and Tiernan Co., to be present during the experimental operation of the plant from April 9th to 19th, inclusive, for observation and such suggestions as they might make looking to the development of this process, or modifications thereof, as would best meet conditions presented by the soft water of low turbidity and containing considerable color of vegetable origin. All of these men were present except Mr. Enslow, who, although unable to come to Mobile at that time, kept in close touch with the progress of the operation of the plant.

Feature of Filtration Plant.—In designing the new filtration plant, one of the two basins formerly used for plain sedimentation was converted into the coagulating basin, part of one end of which was divided into seven rectangular mixing chambers 4 ft. square and 10 ft. deep, connected at the bottom by 12 in. 90° ells with 18 in. nipples, giving an upward velocity to the water as it enters each successive chamber. The total retention period in the mixing chamber is 12 minutes. The total capacity of the coagulating basin is approximately 500,000 gal. The iron sulphate, sodium aluminate, and lime used in treating the water are fed through Wallace and Tiernan dry feed machines and the chlorine is fed through a Wallace and Tiernan Type MSV chlorinator. In order to obtain complete oxidation of the ferrous sulphate, a lard barrel was used for the introduction of both the sulphate and chlorine in such a way as to cause a churning and swirling action, the resultant mixture from this barrel passing to the first mixing chamber where the raw water is introduced. The spot test, using the potassium ferricyanide, was used as a control at frequent intervals throughout the period of operation. Water was pumped at the rate of 700 gal. per minute from the coagulating basin to the filters which consist of two rectangular units each having a capacity of one half million gallons per 24 hours.

Operation of Plant.—The plant was operated both continuously and intermittently. When operated intermittently, the period of operation was 10 hours and remained idle 14 hours. Coagulation was obtained by the use of "chlorinated-copperas" alone and also in conjunction with sodium aluminate. When sodium aluminate was used, it was introduced into the third chamber of the mixing chambers after a theoretical detention of 4 minutes in contact with the copperas. A good floc had already appeared in the second chamber from the use of "chlorinated-copperas" alone. Good coagulation was obtained by using .7 grains per gallon of iron sulphate and .126 grains per gallon of chloride. Although this quantity of chlorine gave excess of 2 parts per million at the end of the mixing chamber, all residual chlorine had disappeared before the water had reached the end of the last day of the coagulation basin. Sodium aluminate, when used, was introduced at the rate of .4 grains per gallon.

Provision had been made for introducing lime at various points in the last bay of the coagulating basin and also into the clear water well. At different times the lime was introduced at a point about 50 ft. from the coagulating water pump, 130 ft. from the coagulating water pump, and into the clear water well immediately adjacent to the filter effluent pipes. When introduced into the coagulating basin, the effluent was not as satisfactory as the final treated water was found to be after the introduction of lime into the clear water well. Although there was a very slight increase in color when the lime was introduced into the clear water well, the color was not as great as the filter effluent was when lime was introduced into the coagulating basin. In all cases, lime sufficient to adjust the pH up to 7.0 or 7.2 was used. The alkalinity was raised to 7 or 8 parts per million. The final color was probably not more than 3. This, however, is an estimated figure, as the lowest disc of the U. S. G. S. color standards which we had was for a color reading of 7. When "chlorinated-copperas" was used alone, for the floc obtained was apparently lighter and was carried in comparatively large quantities a greater distance through

the coagulating basin than was the floc obtained when sodium aluminate was added as described above. However, it was noted that the floc when sodium aluminate was used, was more agglomerated and, although a heavy deposition occurred in the first third of the first bay of the coagulating basin, the remaining floc seemed to have a less specific gravity than that resulting from the use of "chlorinated-copperas" alone. The final treated water obtained, when sodium aluminate was used, was only very slightly different from that obtained when "chlorinated-copperas alone was used for coagulation. No difference could be detected by the ordinary laboratory tests. When viewed through a 10 ft. depth in the clear water well, the opinions of five observers differed as to which effluent was the better or whether there was any perceptible difference whatever. It will thus be seen that the difference in results in the particular water being handled during these experiments would make the additional cost of sodium aluminate questionable — this cost alone being greater than that of all three other chemicals combined.

It must be remembered that this is an absolutely new filtration plant, that the sand has not ripened, and that the period of operation has not been sufficient to demonstrate conclusively what might be expected under the varying conditions of water which will be found through a twelve months' period. However, although these results are not final, we are convinced that this method is practical, economical, and efficient under conditions similar to those now existing. The efficacy, when water of a different quality must be treated, can be determined only after further observation.

Acknowledgment.—The foregoing is a paper presented at the First Virginia Conference on Water Purification and Sewage Treatment, held at Richmond, Va., April 25 to 26.

State Supreme Court Uphold Ohio Sanitary District Law

In a decision handed down March 27, in a case on appeal from the Mahoning county courts, the Ohio Supreme Court affirmed the constitutionality of the sanitary district law, which had been attacked by two citizens of the Mahoning Valley Sanitary District as taxpayers, on the alleged ground that the legislature could not delegate power and authority to levy taxes to an appointive body. Commissioners of the sanitary district are appointed, instead of being elected. Plaintiffs lost in the Mahoning County Common Pleas Court, and appealed on error to the Court of Appeals, which affirmed the decision, and appeal to the Supreme Court followed. This decision removes the last existing legal barrier to progress of the sanitation work designed to furnish pure water to the cities of Youngstown and Niles.

Automatic Devices in Filter Plant

Care and Adjustment of Controller Gauges and Other Mechanical Equipment

By RICHARD F. WAGNER
Director of Safety and Water, Lynchburg, Va.

The city of Lynchburg was very fortunate when securing its purification plant in that the parties charged with its design appreciated the value and importance of certain automatic devices and spared no efforts or expense to secure them.

Automatic Devices.—The more important automatic devices were the following:

1. One 24 in. venturi rate controller, with a register-indicator-recorder and special electrical transmitting device, for operating the chemical feed controllers.

2. Three chemical feed controllers automatically operated electrically from the register-indicator-recorder.

3. Twelve 6 in. self-contained filter rate controllers, one 6 in. wash-water rate controller, and one 12 in. wash-water rate controller, with 14 special rate of flow indicators.

These controllers, consist essentially of a venturi tube, with hydraulic gate valves in the down-stream cone. The movement of the gate valve is controlled automatically so as to maintain a constant rate of flow regardless of pressure variations. The method used in the utilization of the difference of pressure from the venturi tube applied to a diaphragm which in turn operates a pilot valve which controls the movement of the hydraulic gate. The setting of the rate at which the controller operates is accomplished by moving a weight on a graduated scale beam.

A check of the proper working of the controllers is secured by the rate of flow indicators, which consist of a glass tube projecting into a well of mercury with the necessary connection of the meter tube, the difference in pressure causing the mercury to fluctuate in the glass tube.

Care of Packing.—The cylinders of our hydraulic gate valves are brass, so are the gate girders. After a few months' operation of the plant, some of the controllers became sluggish and in some instances it became necessary to remove the caps of the cylinders of hydraulic gates for the purpose of renewing or replacing packing around plunger. This packing, of course, hardens under use and it has been our practice to hammer it back to life after washing it thoroughly in a strong solution of soda ash. We then coat it thoroughly with a mixture of extra light petroleum jelly and flake graphite. It is of a good deal of importance to replace or renew packing in such a manner as to prevent a displacement of gate stem. This we have accomplished by measuring the distance of stems from cylinder walls in four directions before removing packing, taking care that such measurements are accurately secured upon the completion of the repair job.

We have also found that the insertion of a set screw in gate girder stem will prevent too tight a shut down; the screw being set in such a position as to present a complete seat.

We have experienced little if any trouble with diaphragm boxes, taking the precaution, however, of removing tops at certain intervals and cleaning boxes thoroughly.

Our pressure gauges, recording and otherwise, are checked from time to time by a gauge tester, a device every water plant should possess. This tester works by series of weights with glycerine as the fluid used.

Chemical Feed Controllers.—While our chemical feed controllers were designed to work automatically by an electrical device geared to our venturi meter, we found this method impracticable, we, therefore, calibrate the flow from orifice boxes manually once an hour, a program clock calling the attention of the operator on duty to this task. This method has been eminently satisfactory, chemicals consumed being checked once daily against the rate of application. All the attention the chemical feed devices require is a complete cleansing at certain intervals.

Care of Chemical Pumps.—Chemical pumps of the piston type, especially such pumping alum solutions require frequent grinding of valves, which we accomplish identically in the same manner an automobile mechanic grinds the valves of your car, very little practice will soon make your operator an adept in this game.

Though we use chlorine but seldom, we possess three units to apply such gas. We subject these to periodical tests, sometimes with gas, then again with air. One thing of importance, of course, to prevent corrosion and assume long life of this apparatus is to prevent leaks, even the smallest; doing so requires painstaking, thorough attention of the operating personnel.

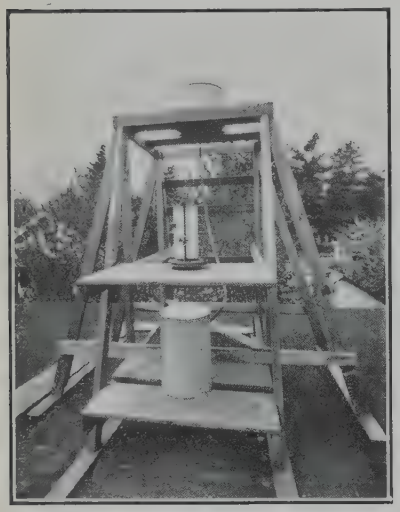
Any plant designed and constructed in accordance with the latest methods will not function properly unless the person in charge of operation is intelligent and has the proper sense of responsibility. This person will soon sense the fact that automatic devices, gauges and other equipment are valuable assistants and will treat them accordingly. He will insist that his personnel also become acquainted with them thoroughly, from the inside out, and that a deal of elbow-grease be applied in keeping them clean and certain surfaces sparkling.

Acknowledgment.—The foregoing is a paper presented at the first Virginia Conference on Water Purification and Sewage Treatment, held April 25 and 26 at Richmond, Va.

Recent Developments in the Water Works Field

A Simple Recording Rain Gage

Leupold, Volpel & Co., Portland, Ore., have recently adapted the Stevens Type L water level recorder to the recording of rainfall. A collecting tank is mounted on a suitable platform and is connected by flexible rubber hose to a float tank. The recording instrument is



Recording Rain Gauge Mounted on the Roof of a Building

placed over the float tank and records the elevation of the water in the tank. The collecting tank and the float tank are so proportioned that any desired magnification of record can be secured. In the bottom of the float tank is a stop cock by which it may be emptied at the time the clock of the recorder is wound.

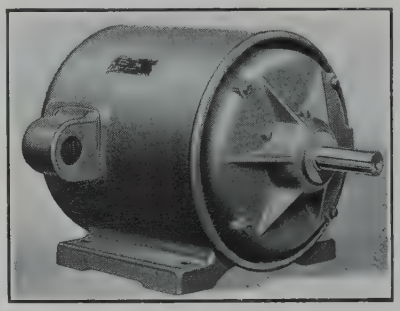
The graph made by the recorder is a mass graph of rainfall by means of which the total amount and its intensity may be readily determined. The illustration shows the recording rain gage mounted on the roof of a building. The collecting tank area is 2.4 times the float tank area. The chart on the recorder is graduated in hundredths of feet with each tenth line accented. Each tenth of a foot therefore on the chart corresponds to a half inch of rainfall, the record being magnified to 2.4 times. Any other scale of magnification can be secured. The instrument shown is a weekly recorder giving a space of about 2¼ in. per day. In cases of heavy rainfalls with great intensities, the same recorder is used, but a daily or a 12-hour chart is substituted and the clock is geared so that the drum makes one revolution in one day or 12 hours. When there is no rain the pencil makes a continuous line, but whenever railfall occurs a record of the amount and intensity is assured to a time scale that will be legible. The daily chart corresponds to a scale of 18 in. per day, with the smallest division of time representing 10 minutes. In the case of the 12-hour chart, the day space is 36 in. and the smallest division represents 5 minutes.

For isolated localities that cannot be visited once a week, a recorder is used that will run one or two months with one setting. In such cases a float tank is provided that is deep enough to hold any amount of rain that might occur during such a period.

During the dry periods following a rain the graph will show a slight decline due to evaporation from the tank. This however is of no consequence, because whenever a rainfall occurs the total amount and the intensity can readily be determined above the point shown by the graph at the beginning of the rain.

New Motors Developed by The Louis Allis Co.

Experience of 1928 assisted The Louis Allis Co. of Milwaukee, Wis., in developing enclosed motors of reasonable size. These are the explosion-proof, self-ventilated motor for use in explosive atmospheres; and the enclosed self-



Louis Allis Enclosed Self-Ventilated Motor

ventilated motor for applications involving less hazard but requiring a fully enclosed motor. These developments, together with our Resistallis protective coating for the windings of open motors, fill industry's need for motors of reasonable size suitable for applications involving various degrees of hazard either to the motor winding or the surroundings. To machinery manufacturers the outstanding advantages of these three types of protected or enclosed motors are that they are small enough for mounting direct on the driven machine. These motors enable the manufacturers to adapt standard machines, built to accommodate standard motors, to hazardous and semi-hazardous industries. The features of the three types are noted briefly below.

The explosion-proof motor is fully enclosed and self ventilated. It has been tested and listed by Underwriters' Laboratories for use wherever gasoline, or liquids of equivalent or less hazard such as other petroleum products, ethyl alcohol, methyl alcohol, and acetone, are made, used, or handled. When direct connected to machines in explosive atmospheres, thus eliminating belts, this motor eliminates the serious hazard of fire from sparks due to belt static. It is only slightly heavier than an open motor of same capacity, can be installed in same space and is interchangeable in mounting dimensions.

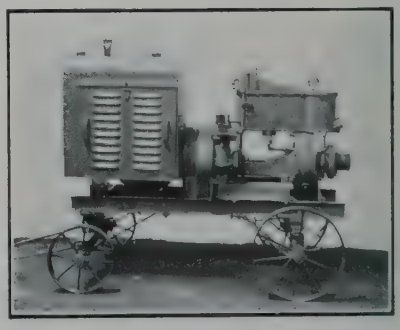
The enclosed self-ventilated motor is fully enclosed and sealed against excessive dust, moisture, oil, acid, alkali, fumes, and other foreign matter. It is cooled by the surrounding air forced through the outer shell over the surface of the enclosed motor frame. Clean air is not required. There are no pipe connections or air ducts. It is only slightly heavier than an open motor, installed in same space, and is interchangeable in mounting dimensions.

Resistallis coating protects windings of open motors and makes them suitable for installations where considerable quantities of organic dust, iron dust, moisture, acid, or alkali are present. Resistallis entirely covers coil ends and slots, is not affected by temperature and does not affect ventilation. It makes a standard motor suitable for reasonably severe duty without added cost.

Self-Priming Portable Centrifugal Pump Announced

One of the latest features of the Domestic Engine and Pump Company's line of water works equipment and one of their most popular units is a self-priming centrifugal pump. Their factory is located at Shippenburg, Pa.

With this automatic primer attached to any of our standard centrifugal pumps it is only necessary to submerge the end of the suction line in water and start the engine. It is not necessary to put water in any part of the pump,



Domestic Automatic Priming Centrifugal Pump

suction line or primer. With a tight suction line it is possible to create a 27 in. vacuum which is equivalent to a 30 ft. suction lift. This primer has been tried out over a period of several years and has proven very successful.

Another new unit is their 1929 Model 164 open spout diaphragm pump with force attachment. They have increased the practical range of diaphragm pump uses by manufacturing an attachment whereby the Domestic open spout diaphragm pump can be converted into a force pump, for temporary use, in a short length of time and with the aid of only one tool, a monkey wrench. They have, in manufacturing this attachment, given the user of such type of pumping equipment something that has been very much needed for some time. It often happens that when using a diaphragm pump the need arises to temporarily force the water away from the scene of action and with this attachment the process is simplified greatly.

Oxweld High Strength Welding Rod

An improved bronze welding rod, designated Oxweld No. 21 high strength bronze welding rod, has been placed on the market by Oxweld Acetylene Company, 30 East 42nd Street, New York City. This rod is recommended for all bronze welding applications including the fusion welding of brass and bronze, bronze-welding of malleable and gray iron castings, joining dissimilar metals and building up bearings

Bronze-Welded 6-in. Galvanized Water Line

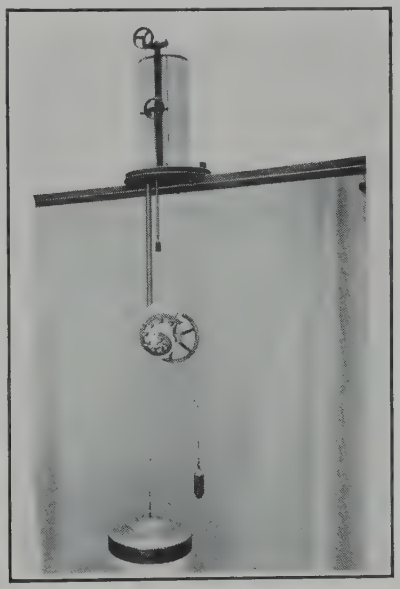
and other wearing surfaces. Due to its composition it has a uniformly low melting point and easily controlled flow. It produces a weld metal as hard and wear resistant as that formerly made with manganese-bronze rod. By its use, tough and ductile weld metal having a tensile strength of over 45,000 lb. per sq. in. can be produced. This is about 15,000 lb. per sq. in. in excess of the strength obtainable with earlier bronze welding rods. In addition, it will make a much stronger bond with ferrous metals.

Properties of this rod eliminate almost all boiling and fuming of the weld metal. Annoying fumes are reduced to a minimum and elimination of oxide and gas inclusions is a reason for both the remarkably sound and strong weld metal produced and the better adhesion to iron and steel.

Oxweld No. 21 high strength bronze welding rod has been thoroughly tested in the laboratory and in the field. It is believed that it will greatly widen the already broad scope of the most versatile of all the oxy-acetylene operations, bronze-welding.

A New Flow Recorder

The illustration shows a device recently perfected by Leupold, Volpel & Co., Portland, Ore., manufacturers of Stevens water level recorders and indicators, whereby the flow in second-feet, gallons per minute, liters per second, or



A New Flow Recorder

any other unit may be recorded on a chart to a uniform scale.

Attached to the base of the instrument is a float pulley which actuates an adjustable spiral cam, which in turn actuates the recording pencil on the recorder. For weirs, sewers, flumes or ditches, where the rating is known or for any device where the height of water is an index of flow the cam may be adjusted so that the pencil will record the flow in any desired units. The spiral is a strip of rubber in which a groove has been milled that is held by clamps. If the rating of a device is known, the rubber cam is clamped in such a position that at all points the pencil will show the correct flow corresponding to these heights.

The instrument may also be provided with Stevens volume meter, which is a totalizing device by means of which the total volume passing in gallons, acre-feet, or any other unit or quantity is registered on dials.

When required, an additional pencil is provided that will record head at the same time, so that this simple device may be used to record head of water, flow, and total volume.

Quinn Develops New Machine

An improved Quinn machine for the manufacture of concrete pipe in sizes 18 in. to 60 in. in diameter and lengths

Quinn Improved Pipe Machine

of 4, 5 and 6 ft., tongue and groove pipe ends. The Quinn Wire & Iron Works of Boone, Ia., are the manufacturers.

This machine has a capacity of from 75 to 100 tons per day depending on the size of pipe being made. It makes either plain or reinforced pipe, single or double reinforcing. The tamping mechanism on this machine strikes a very powerful blow, in fact when the jackets are removed from the concrete which is done immediately after the pipe is made, the material is so dense and hard that it is almost impossible to dent same by applying pressure to the outside or inside.

The improved Quinn machine has the advantages over other processes of making concrete pipe in that it not only makes a pipe economically, but it produces a pipe of the very highest strength, owing to the fact that it uses a semi-dry mix with very little slump and just enough water to hydrate the cement and by applying the terrific trip hammer blow of from 600 to 700 lb. each blow. Operating 370 times per minute, the hammering effect produces a very dense, hard and compact material as it is forced into the forms. This process develops a very high strength in the concrete, eliminates all air pockets and forces the material together in a dense mass. This also gives a very low absorption.

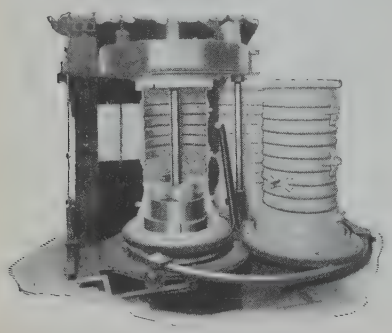
It has been demonstrated from various tests made of Quinn pipe in the larger sizes that the first crack test exceeds all other processes on the market today. Purchasers of pipe and engineers in charge are realizing more and more the importance of high strength in their concrete for sewer work and to this end are recognizing the first crack test as being the most important.

Longer Concrete Pipe Manufactured

Engineers, officials and contractors who specify, approve and use sewer pipe, will be interested in the announcement that McCracken corrugated concrete pipe are now made in three-foot lengths instead of thirty-inch lengths as was formerly the case.

McCracken concrete pipe are made in a number of strategically located local plants. These plants operate concrete pipe machines, manufactured by the McCracken Pipe and Machinery Corporation, Sioux City, Iowa. The company announces a second improvement in concrete pipe manufacture which increases the daily output of each plant and results in a definite improvement in the product.

The McCracken machine automatically manufactures sewer pipe from six



Showing McCracken Wall Packer at Bottom of Its Stroke

to twenty-four inches in diameter, three feet long. Each pipe is made in a steel jacket which is released from the green pipe immediately the product has been wheeled to the curing room.

In every McCracken pipe plant a conveyor line keeps the mixer supplied with raw dry materials and the mixed concrete is discharged into the elevator boot of the pipe-making machine. From that point to the completion of the manufacturing cycle, the operation is automatic. The elevator lifts the mixed concrete above the mold, which stands on a revolving table, depositing it in a circular batch hopper just above the mold.

Hence the concrete feeds automatically into the mold when the revolving wall packed reaches the bottom of its downward stroke. At this point the auxilliary bell packing head is at its top position making the bell or socket of the pipe. This requires from five to seven seconds. At the same time the wall packer on the main vertical shaft is packing the shoulder above the socket. Then the two packers draw apart—the bell packer moving out of the finished socket and the wall packer rising through the pipe packing the wall as it rises.

Until quite recently as much time was consumed in sending the wall packer down through the mold, which is an unproductive trip, as was consumed in bringing it up through the mold during its packing operation. Thus 50 per cent of the time of the wall packer was unproductive. An improvement of the machine has resulted in cutting the unproductive time of this unit down to 20 per cent. In other words, it travels on its downward trip much faster than it travels on its upward trip. This not only speeds production but results in a definite gain in quality.

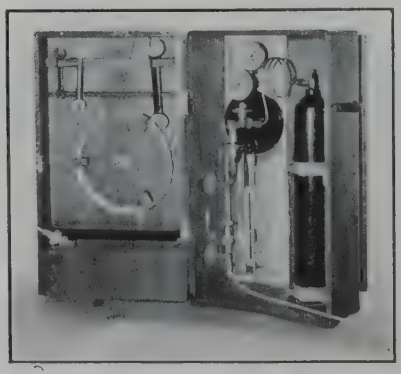
A New Portable Chlorinator

The Paradon Manufacturing Company, Arlington, N. J., have developed a portable chlorinator which can be moved about from place to place as conditions require.

The apparatus consists of a standard Paradon dry feed chlorinator housed by means of brackets in a sturdy oak cabinet. This cabinet is self-supporting. The cabinet is provided with a door on both front and rear. The gauges and control handles of the chlorinator are so arranged as to be accessible from either the front or rear door. The front door is constructed so that the wrenches and other auxiliary equipment supplied with the chlorinator can be stored loosely in the recesses provided. A 12 lb. cylinder of chlorine is attached within the cabinet by adjustable clamps.

All of the parts of the apparatus are interchangeable with the parts on the standard Paradon Chlorinator. This insures prompt service in connection with replenishment of parts. The equipment can at any time be removed and set up on a pedestal and it then becomes a standard permanent chlorinator.

The chlorinator is of the direct feed type. No auxiliary water supply or piping is necessary for its operation. Chlorine can be applied against pressures up to 25 lb. per sq. in. without any additional equipment. Capacities range from .04 lb. to 3 lb. per 24 hours, from 1 lb. to 5 lb., from 5 lb. to 25 lb. and from 25 lb. to 125 lb. The apparatus can be provided with all four ranges, if desired. Any desired capacity from 125 lb. to 300 lb. chlorine per 24 hours can be supplied if required.



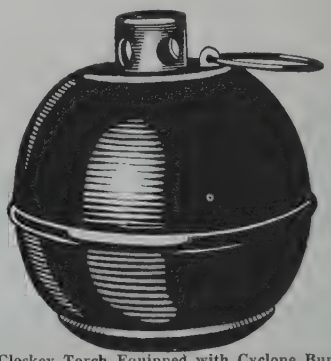
Paradon New Portable Chlorinator

The apparatus is provided with a shut-off valve which enables chlorine gas to be kept in the machine at all times under pressure, thus eliminating the possibility of water or moisture getting back into the apparatus and affecting its proper operation.

The uses of the portable chlorinator are many. It is a convenient device to have around a water works plant. One very useful purpose it serves is to provide means for sterilizing mains at all times. After a main is constructed and before it is put into use it can be effectively sterilized by means of this device. Dead end mains, showing signs of after contamination, can likewise be sterilized. The portable chlorinator can be used as a standby for the regular chlorinator. It can be used for prechlorination, algae control, odor control, color control, coagulation control. It can also be used for the application of sulphur dioxide in dechlorination, for carbon dioxide, and so forth. This unit was originally developed for the Water Department of the City of Syracuse where one has been in service with success for several months.

McCloskey Announces Torch Attachment

The McCloskey Torch Company, of Toledo, Ohio, announce their new Cyclone burner. The torches which are not equipped with this burner can



McCloskey Torch Equipped with Cyclone Burner

readily be converted by using an adapter for the purpose.

McCloskey torches are made in two halves, of rolled and pickled deep drawn steel and welded together. Sufficient cast iron counter balance pressed in the bottom absolutely prevents them from being knocked over.

The No. 1 large size torch, the manufacturer states, is made of 13 gauge metal, holds a quart of kerosene, and burns for 48 hours. The No. 3 size is 15 gauge metal, holds 3 quarts and burns 36 hours.

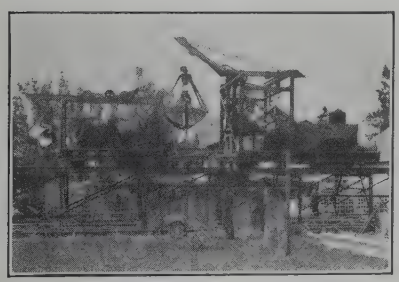
Further information may be obtained from McCloskey Torch Co., Toledo, Ohio.

Potter Improved Trench Excavator

The new Potter trench excavator handles a wide range of work and has built sewers of pre-cast construction from a diameter of 2 ft. to 8 ft. and in depths from 8 ft. to 35 ft. and widths up to 14 ft. The standard length of the trestle is 200 ft.

This machine is manufactured by the Potter Manufacturing Co. of Indianapolis, Ind.

Two standard double drum Lidgerwood gasoline hoisting engines are used for power, the one on the derrick car is a Buda 50 hp. engine and the



Potter Trench Excavator and Conveyor

one on the conveying car a Buda 30 hp. The clam shell is a ¾ yd., narrow type, heavy duty Owen bucket.

The whole machine can be moved ahead at will on railroad rails as each bent leg has a double flange wheel that runs on the rail. The bents are spaced 10 ft. apart and the track gage at the bottom is 10 ft. 4 in. and the track gage on top is 10 ft. 4 in.

The conveying car is a combination hoist and conveying car and receives the excavation from the clam shell and conveys the excavation back and dumps it on the completed work, while the clam shell is going down after another bite, thus doing double work.

The hoist feature lowers pipe into the ditch and does general hoisting work, such as pulling sheeting and bracing timbers out of the trench.

A vast amount of work can be accomplished with this machine and the use of it makes a clean organized job, all operations being carried on simultaneously, the excavating, sheeting, pipe laying and back filling. It is not necessary to pile the excavation on the abutting property owner's front yard or property. The machine handles work in narrow alleys, up city streets or out in the open. It permits the operation of street car and vehicular traffic in city streets where the sewer is on one side of the street.

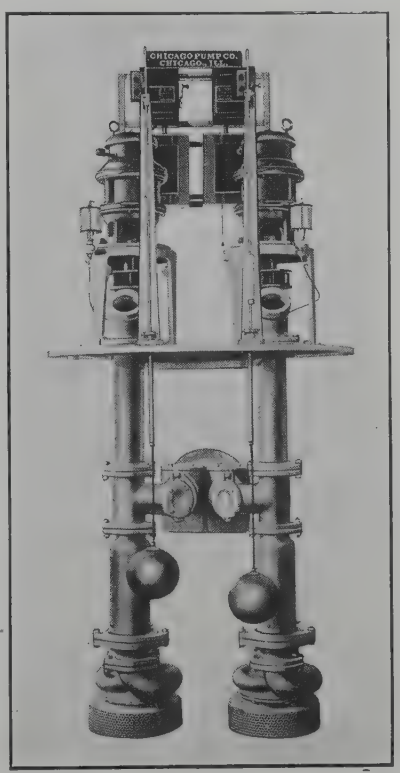
It requires two operators for the machine, which are at all times directly over their work. The operator on the derrick car can spot his bucket in the ditch with great accuracy and can move from one digging section to another with practically no loss of time and can handle as many digging sections or steps in the ditch as is necessary, according to the depth and the type of sewer required. The conveying car operator can spot the back fill in a most advantageous way, to extract the sheeting and bracing in the most economical manner. This enables the operation to become speedy and efficient.

The machine has surpassed the expectations of each sewer contractor that has used it, and has completed work far ahead of schedules laid out, the manufacturer claims. It has been used on small contracts and one up to $2,000,000. This machine has been very much in favor with city officials, on account of the fact that the sewer work can be handled with great speed and permits traffic to be kept open on main thoroughfares and makes for a neat, clean job, eliminating the piling of excavation on the side of the trench, or on abutting property, which invariably causes a lot of dissatisfaction where that is the practice.

Improved Sewage Ejector

The Chicago Pump Company, Chicago, Ill., calls attention to the following items which were recently brought out and have a use in the water works field.

First in importance is the Flush-Kleen sewage ejector. The important point about the Flush-Kleen sewage ejector is that it will discharge large and heavy materials. The submerged Flush-Kleen will pump successfully into the sewer, any sewage or foreign material which can run into a basin from sanitary lines. The Flush-Kleen sewage ejector has a self cleaning screen and rags, sticks and paper cannot clog the impeller because they do not come in contact with it. It is controlled by the Automatic Alternator which causes pumps to alternate their operation. First one pump takes up the work and then the second pump goes into operation while the first pump is at rest.



Flush-Kleen Sewage Ejector

A bulletin issued by the Chicago Pump Company goes into detail on all these points.

Second in importance to the water works field is the Non-Clog sewage ejector.

The Non-Clog like the Flush-Kleen, does not need a screen. It will pump heavy cumbersome materials and will pass wooden balls as large as 3⅝ in. in diameter. It will be observed that Non-Clog impeller will discharge any substance or objects which can pass into it.

The Non-Clogs are particularly adapted for lift stations in the smaller towns and municipalities.

The impeller has but two blades with carefully rounded edges. All water ways are smooth. There are no projections on which rags, strings or other material can catch.

It is keyed to the shaft and is held in place against shoulder on the shaft by a brass locknut.

High efficiencies are obtained over a wide range of capacities and heads due to very careful design and experience in pump building.

The Little Giant electric cellar drainer can be used to advantage in bilge and sump work where medium quantities of water are to be handled.

H-Section Fence Posts Announced

The Cyclone Fence Co., of Waukegan, Ill., announces the introduction of H-section posts for use with Chain Link fence guard.

In the past, fence builders have been dependent upon the use of standard shapes for posts and the fence built to adapt itself to the available shapes. The H column post is the first shape which has been designed particularly for use with Cyclone Chain Link fencing to insure maximum strength. A liberal margin of safety has been allowed in designing this post for the particular service which it must perform.

Its analysis, its measurements and its appearance have been agreed upon by both fence and steel research engineers after experiments carried on over a period of several years.

It is galvanized in Cyclone factories by the Cyclone Galv-After process and each post is embossed with the word Cyclone at four foot intervals.

It has a copper content of approximately .20 per cent.

C. H. & E. Sewage, Trash, Triplex Lift and Force Pumps

The C. H. & E. Manufacturing Co., Inc., Milwaukee, Wis., is now manufacturing a line of five sizes of sewage and trash pumps, powered by four cylinder engines from 15 to 45 h. p. through flexible coupling, with capacities from 400 gallons per minute at 50 ft. total head, to 2500 gallons per minute at 35 ft. total head.

These pumps are for the economical handling of fluids containing large solids and much foreign matter, particularly material of fibrous or stringy character such as is found in sewage. These pumps have two very definite advantages which greatly influence the efficiency and economy of operation; first, continuity of performance, without clogging; second, the elimination of the necessity and expense of screening out solid material in the fluids to be handled.

The impeller will pass anything that enters the suction nozzle, the pump being designed to handle solid spheres as large in diameter as the pipe size next smaller than that with which the suction connections to the pump are made.

In construction and drainage service they are used to great advantage where the water to be pumped contains rubbish, roots, sod, weeds or other objects which clog ordinary centrifugal pumps that have been tried unsuccessfully for trash pumping service.

These outfits are mounted on steel skids or steel trucks. Priming pump, clutch and all discharge fittings are standard equipment.

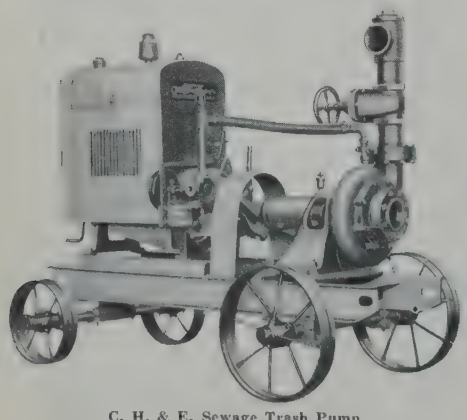
A new Triplex lift and force pump has been developed by the C. H. & E. Manufacturing Co., Inc., of Milwaukee, Wis.

This is a very sturdy, dependable outfit, designed to handle water carrying a large percentage of solid matter, and to force the water away from the job.

The outstanding features of this Triplex lift and force pump are a high suction lift, and self-priming, which eliminates constant attention.

Large metal valves are used, and there are large openings in the valve seats to allow solid matter to pass through. The suction and discharge valve cases and the water box are designed to allow the water to flow freely. The valves are very accessible, each valve having an individual cover held down by a clamp. The clamp is slotted on one end, which only necessitates the loosening of one nut a few turns to remove the clamp and valve cover.

This pump has machined cross-head guides which are lubricated from the plungers. Packing is not used as a quide for the plungers. The plungers are outside packed and easily accessible. Connecting rods are of the eccentric type, lubricated by individual sight feed oilers. The pump is driven by two machine cut gears of wide face. It will develop a 25-in. vacuum, and handle up to 100 well points, it is claimed, depending on the size of the points used and soil conditions.



C. H. & E. Sewage Trash Pump

Byers Announces New Process for Wrought Iron

The culmination of ten years' research work in the metallurgical field is reflected in the announcement of the A. M. Byers Company of Birmingham, Ala., at the American Water Works Association Convention of their new process for the manufacturing "Genuine Wrought Iron."

Briefly, the new process reproduces the same reactions that took place in the hand-puddling furnace, but with greater uniformity. Tests by leading metallurgists from Great Britain, Germany, and the leading railroads and petroleum interests of this country, indicate an iron with almost perfect slag distribution.

Pipe manufactured from the new material welds better, fabricates more easily and contains possibilities of being ultimately manufactured on a scale comparable with that of steel.

In the Byers new process, the definition of wrought iron, the temperatures and the chemical reactions which took place in the older processes have served as guides in working out several independent but definitely related steps. Above all, the principle is kept in mind for a composite material consisting of a refined base metal and slag. These two elements are therefore first produced separately and then mixed in such a manner as to produce a spongy ball which in all particulars, except in size, is identical with that obtained in a hand-puddling furnace.

The base metal refined may be carried out in slightly modified Bessemer, open hearth or electric furnaces. The pig iron is refined to an exceedingly low metalloid content, particularly with respect to carbon, silicon and manganese.

Slag is melted in standard types of furnaces from readily available raw materials, chiefly iron ore, roll scale and sand. The molten slag is an iron silicate conforming to the composition and characteristics of slag formed in the best hand-puddling practice.

The crux of the Byers new process lies in the so-called "shotting" operation. This operation consists in pouring the liquid metal which, as is well known, carries large amounts of gases in solution into a bath of molten slag. When the molten iron at a high temperature strikes the molten slag at a slightly lower temperature, there is, due to the sudden drop in temperature, almost instant solidification of the metal, and the gases are expelled with such a force that there are a million tiny explosions which have the effect of instantly disintegrating the metal as perfectly and uniformly as it may be observed to take place, though at a much lower, slower rate in a hand-puddling furnace.

The semi-solid globules of metal, owing to their high specific gravity, settle to the bottom of the slag bath, forming a spongy, porous mass of exactly the same composition as a puddle ball. In the heat interchange, hot metal naturally raises the temperature of the slag so that it remains liquid, thoroughly coating each globule as fast as it forms, and filling the interstices of the entire metallic mass.

From this point on, no change in the manufacture of the iron is made, except that the equipment is much larger and much heavier, due to the fact that the puddle ball is ten or more times larger than that produced in the former hand-puddling process.

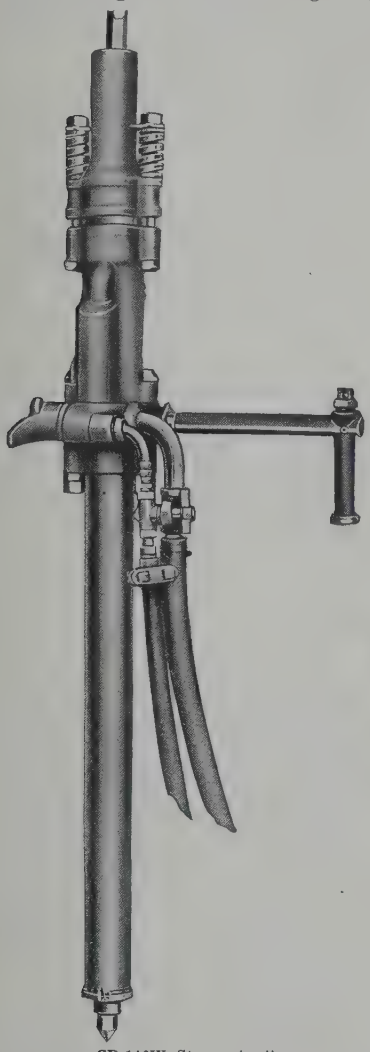
Sweet Designs Fence Post

Sweet's Steel Co. of Williamsport, Pa., announce production of steel posts of flanged leg channel section. The posts have been designed from the results of research. The tests conducted were interpreted by the company in such a way that they eliminate ground plates.

Their posts are equipped with rivet lugs for holding fence or wires where desired. This method, the manufacturer states, of attaching fence to posts is exclusively a Sweet's feature. They state that by the rivet lug method the shearing of fence wire is reduced to a minimum.

Hand-Rotated Stopers

The Chicago Pneumatic Tool Co. of New York, have perfected their stopers and state that the CP-146W stoper (wet) combines high drilling speed, light weight, short overall length, ease of operation, low upkeep and effective and convenient air feed control for difficult drilling conditions. Being fully



CP-146W Stoper (wet)

cushioned and valve actuated, it does satisfactory work under poor conditions such as low air pressure, wet air and the added handicap of worn parts.

The main features incorporated in this drill can be summarized as:

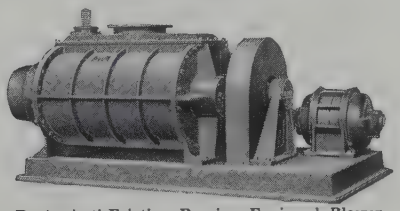
(1) Symmetrical balanced design—easy to operate.
(2) High drilling speed over a wide range of formations and conditions.
(3) Light weights.
(4) Four-bolt construction—gives ready accessibility to all working parts.
(5) Spring-retained front head.
(6) Fully cushioned, one-diameter piston—insures long life.
(7) Rugged, tubular valve, housed in renewable bushings in the cylinder wall, and piston-controlled exhaust—absolutely no tendency to "freeze" under the worst conditions.
(8) Effective, air-operated feed control, conveniently located in the rotation handle.
(9) Full 24-in. feed travel—facilitates steel changes.
(10) Air and water swivel connections conveniently located.
(11) Automatic lubrication.

Roots Blowers Now Use Anti-Friction Bearings

The P. H. & F. M. Roots Company, Connersville, Ind., originators, patentees and manufacturers of two-impeller rotary positive displacement units, announce the general adoption of anti-friction bearings for their blowers and Acme blowers.

The standard line of blowers carries Timken or SKF heavy duty roller bearings upon the purchasers' specification, and the Acme line of smaller units carries roller or ball bearings upon specification.

Constant research and construction work over a period of the past twenty years has convinced The P. H. & F. M.



Roots Anti-Friction Bearing Equipped Blower

Roots Company, established 1859, that the manufacture of anti-friction bearings has now been perfected to the point where they recommend and use them.

A roller bearing has not merely been substituted for one of the adjustable babbitted type. The Roots Blower construction has been re-designed entirely, and changed to allow every additional operating advantage. Extreme care has been taken in designing the mounting. Complete protection from the entrance of foreign substances into the bearing housing has been afforded. Ample space is allowed around the bearing for a sufficient supply of lubricant, and provision is made for forcing the lubricant through the bearing from one side to the other.

In no case does the maximum load and speed of the bearing selected exceed one-third of the manufacturer's rating. Aside from the reduction in friction loss, Roots blowers with anti-friction bearings offer new possibilities for direct connection to smaller motors with less horsepower to obtain increased capacities, operate with higher efficiency by permitting the use of more closely fitting cases, permit greater capacities with conservative speeds, and deliver more volume with less horsepower.

Before the adoption of anti-friction bearings, The P. H. & F. M. Roots Company had listed 141 different applications of their products throughout all industry, and the change to the roller and ball constructions opens even a wider field for the use of rotary positive displacement blowers thus equipped.

Link-Belt Announces a Complete Line of Gasoline Locomotive Cranes

Even locomotive cranes are now driven by gasoline engines. Link-Belt Company, Chicago, Ill., has announced a complete line of locomotive cranes designed especially for gasoline engine, Diesel engine or electric motor drive, to be known as the L type cranes.

They are not merely modified steam cranes, but are designed throughout for the entirely different and much more severe conditions imposed by a power unit running continuously at its full operating speed.

The machinery and its arrangement are particularly adapted to direct engine or motor drive, and all clutches, brakes, shafts, bearings, gears, etc., are oversize in order to give the best operating results and the lowest possible maintenance expense, under these conditions.

The drive from engine or motor is a totally-enclosed silent chain drive, and all upper frame gears have machine cut teeth, cut from solid blanks. This makes a quiet, smooth operating machine.

It is furnished with two-speed travel gear to give a high travel speed for traveling light, and a slower travel

Link-Belt Locomotive Crane

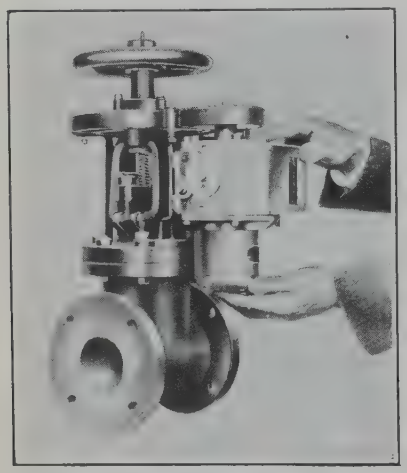
speed for pulling heavy loads or ascending comparatively steep grades. The two-speed travel gear in no wise affects the other speeds of the machine (hoisting, boom hoisting and rotating), which should, under all conditions, remain unchanged in order not to affect the operating speed and handling capacity of the machine.

The addition of the L-type crane in five sizes gives Link-Belt Company a complete line of gasoline, diesel, electric and steam locomotive cranes, and a line of heavy duty gasoline, diesel, or electric crawler shovels, cranes and draglines ranging from ¾ cu. yd. to 2 cu. yd. capacity.

New Motor Driven Mechanism for Operating Valves

A new motor driven valve operating unit has just been announced by The Cutler Hammer Mfg. Co., Milwaukee, Wis., which makes possible automatic operation of all valves up to 6 in.

Although so small that it can be held in one hand, this unique operating unit



Cutler-Hammer Motor Driven Valve Operating Mechanism

has a rating of 15 ft. lb. It can be operated automatically by means of float switches, temperature controlling devices, pressure regulators, etc., or by conveniently located push buttons.

Although only recently placed on the market this valve operating unit is similar in principal to the standard C-H Dean operating unit which has a successful record of 12 years.

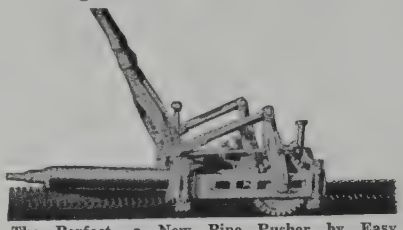
While designed primarily for valve operating service in industries where regulation of pressures and temperatures of gases and fluids is necessary, it is likewise adaptable to many miscellaneous applications, such as operating skylights, awnings, radiators, garage doors, etc.

Literature describing this new unit (called C-H type valve operating unit) will be sent free, upon request to The Cutler-Hammer Mfg. Co., 1298 St. Paul Avenue, Milwaukee, Wisconsin.

Improved Pipe Pusher

The Perfect size Easy pipe pusher was developed by the Easy Manufacturing Co., of Lincoln, Neb., to meet the demand for water companies for a powerful machine to push service pipes through the ground without digging trenches.

This new Perfect size machine is double geared and has two speeds so it



The Perfect, a New Pipe Pusher by Easy Manufacturing Co.

is rapid in ordinary work, yet when hard pushing is encountered or when large pipes are to be pushed, the machine can be put in low gear and in this way a greater pressure can be exerted. The machine is malleable and cast iron and drop forged steel. It is equipped with three pilots and will handle from ¾ to 2½ in. pipe. These pilots are all hollow so that water under city pressure can be put right up to the front end of them. In hard or dry soil this reduces the power required to push pipe at least one-half.

Following are specifications relative to the new Perfect:

Length of track 60 in. Weight of track 100 lb. Length of carriage 21 in. Width of carriage 15 in. Weight of carriage 125 lb. Shipping weight 280 lb. Double driving gears, double the power. Two speeds for different work and soils. In low speed, one man can push over 100 tons. In high speed he can push 40 to 100 feet per hour. Drop forged, heat treated vise jaws which positively hold the pipe. Machine is made of malleable iron, cast steel and rolled and drop forged steel. Handles ¾ to 2½-inch pipe.

New Use of Road Guard

The American Wire Fence Company of Libertyville, Ill., have developed new uses for American Life Net Guard.

An increasing number of municipal officials are finding it advantageous and advisable to protect properties such as parks, golf links, playgrounds and similar areas from promiscuous trespassing by automobiles. Such areas

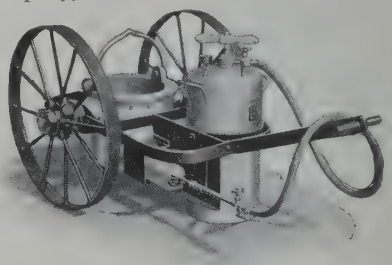
American Life Net Guard Prevents Road Encroaching on Municipal Golf Course

being primarily intended for recreation, automobiles not only damage the grounds but offer serious menace to life and limb.

An installation of American Life Net Road Guard as manufactured by the American Wire Fence Company protects such grounds from motor traffic but does not restrict pedestrians. The company will be glad to offer the aid of their experience along these lines to anyone asking for it.

Littleford Develops Lead Furnace

A new portable lead melting furnace, manufactured by Littleford Bros., Cincinnati, O., increases the efficiency of the pipe laying gang. Water works departments find that the torch-type oil burner not only melts lead very rapidly, but it can be easily detached



New Lead Melting Furnace by Littleford

and used to melt lead compound from old joints.

Littleford lead melting furnaces are made in 250, 350 and 450-lb. sizes. Both portable and stationary outfits are available.

Copper Service Pipe Developments

The past year, according to the American Brass Company, has witnessed a more widespread use of flexible copper service tubes with compression fittings for underground service lines for waterworks.

As rust constitutes a great menace to water distribution systems, one of the foremost requirements sought in pipe for service lines is corrosion-resistance, both internal and external. This, coupled with the need of strength, ductility and ease of installation, has brought about the increased demand for flexible copper service tubing.

Furnished customarily in straight lengths or coils, all the work required for an installation is easily done on the job. A hacksaw is suitable for cutting to any desired length. This tubing can be connected directly with the corporation stop without a gooseneck and easily bent to avoid underground obstructions. For casual bends, flexible copper service tubing may be worked cold by hand, and where a sharp bend is required a bending jig proves entirely satisfactory.

The freezing hazard, risk of pipe

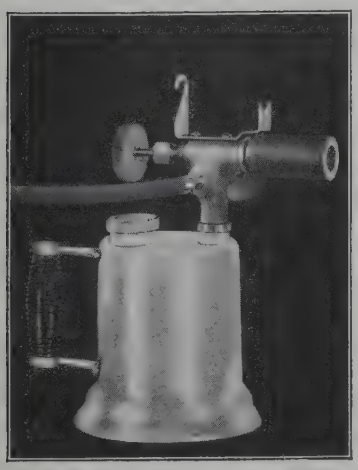
bursting from expansion in cold weather, is always a problem when ferrous service pipes are used. Strength and ductility render copper or copper alloys highly resistant to ill effects from freezing; the ductility will safely compensate for a change of as much as 15 per cent in the diameter of seamless copper tubes, it is claimed.

With modern street paving the costs incidental to replacing services installed beneath permanent highways is a serious consideration. Copper service tubes cannot rust, and consequently are not subject to stoppage because of rust accumulations. A smooth inner surface insures a clear, unrestricted flow at all times.

With a view to increasing the corrosion-resistance of this material, The American Brass Company, of New York, deoxidizes all seamless flexible copper service tubes. Smaller sizes of Anaconda tubing may be used with an ample margin of safety for working pressures up to 200 pounds. Detailed information regarding dimensions, physical properties, etc., of cold drawn copper tubes may be had by asking the above company for its publication C-9.

New Blow Torch Announced by Electric Sprayit Co.

The Sprayit blow torch, new in principle, design and construction, has just been announced by the Electric Sprayit Company, Inc., of South Bend, Ind. Due to the originality of its operation and design, there is no need to pump



Sprayit New Blow Torch

it, no priming and no preheating. A hot, blue working flame is instantaneously available for the job at hand simply by turning the valve and striking a match.

In addition to having the advantage of burning common kerosene instead of costly high test gasoline, the Sprayit blow torch actually produces 30 per cent more heat with the low priced fuel than others can produce with gasoline. As pumping and priming have been dispensed with, there is no chance to have dangerous fuels dripping from the torch. Due to a complete pressure break-up of the fuel, there is 100 per cent combustion and no carbon deposit.

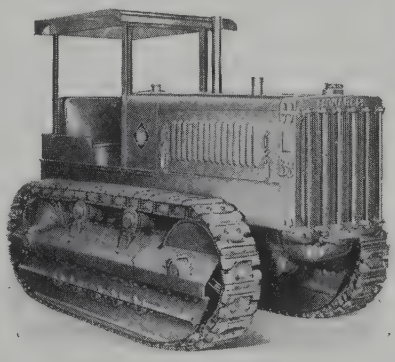
This new torch is so designed that it may be attached to any air supply. Hundreds of mechanics and tradesmen who need both a blow torch and a spraying outfit for their work, have found many distinct advantages in the Sprayit combination set, which consists of a complete electric Sprayit with compressed unit and the Sprayit blow torch which is interchangeable with the Agitator type electric Sprayit gun.

A New Allis-Chalmers Monarch Tractor

The Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin, announces a new track-type tractor for production and sales at their Springfield, Illinois, plant, the Monarch tractors division.

This new model is known as the Allis-Chalmers Monarch 35.

It offers a maximum of 36 drawbar



Allis-Chalmers New Monarch 35

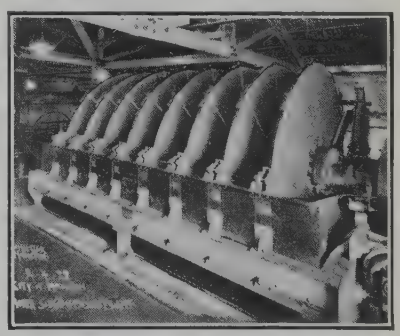
horsepower, three speeds forward and one reverse, 1.84, 2.75, 4.00 and 2.12 respectively. The engine is of a standard Allis-Chalmers type, designed and used exclusively for tractor work, and has four cylinders with removable sleeves set in the block, 4¾ in. bore, 6½ in. stroke. Motor speed under full load is 9.30 r. p. m., and is under governor control. Length over all, including starting crank, is 10 ft., 4 in., width overall is 5 ft. 2 in., height to top of radiator 5 ft. 1½ in. A full pressure lubricating system and an oil Pur-O-lator add considerably to its economical operation.

The track is of extra length as in the larger models, the 50 and 75, providing maximum traction ability, and an even distribution of weight. Features pertaining to the ease and facility of operation and the operator's comfort are incorporated in this machine. Steering is accomplished with a steering wheel and through steering clutches enabling the tractor to virtually turn in its own length. The Allis-Chalmers Monarch 35 is conservatively rated in accordance with the policy of the Allis-Chalmers Manufacturing Company in always maintaining an adequate reserve for peak loads. In general design, construction, and appearance, it is similar to the Allis-Chalmers Monarch 50 and 75 Tractors.

Activated Sludge Filters

The activated sludge process of sewage treatment still holds a strong position in the sewage disposal field and has been definitely adopted by a number of municipalities.

Continuous vacuum filters for de-



American Continuous Filter Installed at Houston Sewage Disposal Plant

watering the sludge formed have been continuously improved by the Oliver United Filters, Inc., of Chicago.

Activated sludge has proven a usable fertilizer, and, when recovered by filtration on continuous vacuum filters and subsequently drying to about 10 per cent moisture in rotary dryers, it has assisted in paying the cost of operating sewage disposal plants by those who have installed this system.

Recent improvements have developed a material increase in filter capacity over original results. A reduction of the moisture of the solid as discharged from the filter, and elimination—or at least a material reduction—in the tendency of the filter medium to become plugged and impervious to further filtration are results of improvements.

All of the above mentioned improvements are due to proper conditioning, control and mechanical handling of the activated sludge and have been demonstrated as being practical and obtainable by several plants.

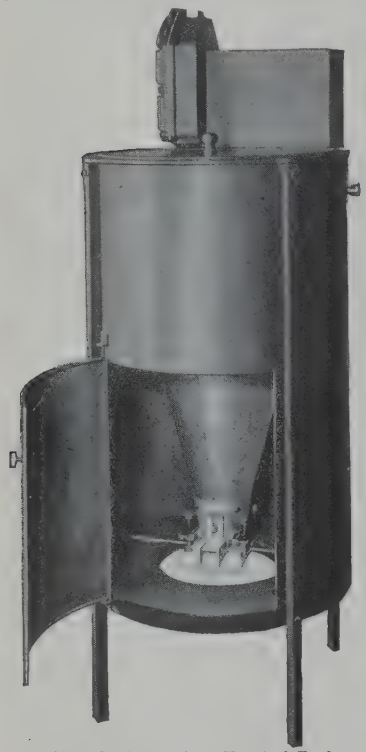
The city of Houston, Texas, using the activated sludge process, filters and dryers, is obtaining results more favorable than originally expected and is having no trouble marketing the fertilizer.

The sludge delivered to the filter at this plant averages around 99 per cent moisture and the solids as discharged from the filter about 77.5 per cent moisture. Capacity runs around 0.623 lb. per square foot of filter area per hour on the basis of 10 per cent moisture solid.

W & T Announces a New Chemical Feeder

Wallace & Tiernan Company, Inc., of Newark, N. J., have just announced their latest dry chemical feeder known as Type O. This feeder, which is the product of five years extensive study and research, has many novel features.

Designed essentially as a low capacity feeder, it has an unusually wide



Wallace & Tiernan Dry Chemical Feeder

operating range and may be used for either fine or relatively coarse chemicals. The minimum rate of feed averages 0.1 lb. per hour for all chemicals. The maximum varies from 40 to 80 lb. per hour, depending on the chemical handled.

Perhaps the most novel features of design are the flexing mechanism of the hopper, the oscillating spout and the convenient, accurate adjusting mechanism. The sides of the hopper are flexed by means of levers near the top which alternately pull in and push out the sides. This method of agitation positively prevents arching and keeps the contents of the hopper moving downward. A vertical agitator is provided for use with light chemicals.

The discharge from the oscillating spout is in the form of a ribbon and the rate of discharge is determined by the length of ribbon pushed off the feed plate at each stroke of the spout. The spout stroke is regulated by a hand wheel having a 100 division circular scale. This long scale, which makes two revolutions in covering the full feed range, makes adjustments easy and accurate. In addition to the spout stroke adjustment the cross section of the chemical ribbon may be varied.

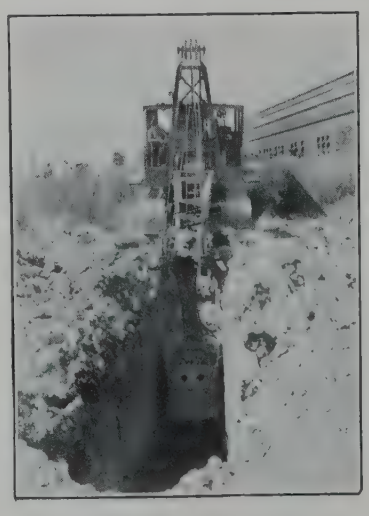
The equipment is operated by a 1/6 hp. motor. The gear case is completely enclosed. The gears run in a bath of oil. Bearings exclusive of the gear case are fitted with special felt washers to keep oil in and dust out. The equipment is enclosed, and is thereby dustproof. It is adaptable for overhead feed with either direct or solution discharge to the point of application. When solution feed is desired a circular solution pot is provided. The water enters the pot at a tangent and the solution is discharged through a central overflow outlet. High velocity and violent agitation makes the chemical solution with a minimum of water. Baffles are provided to prevent flooding.

Bucyrus-Erie Announces D-2 Drag Shovel

The Bucyrus-Erie Company of South Milwaukee, Wis., have brought out a new drag shovel which they call their model D-2.

This machine is a diesel equipped unit which is the result of their 49 years of experience building excavating equipment. The diesel engine on this 1-yd. drag shovel is a 4-cycle, 4-cylinder engine with 6½ in. bore and 8½ in. stroke. It runs at 550 rpm. No priming and preheating is necessary according to the manufacturers. In starting they state, the engine is rotated from an air reservoir and, with the opening of a fuel valve, it delivers full power at once.

On the D-2 diesel drag shovel two of the outstanding features are the ruggedness of the front end and its extreme simplicity. Long life of cable is brought about by the fewest possible bends in the rope and good-sized



Bucyrus-Erie New D-2 Drag Shovel

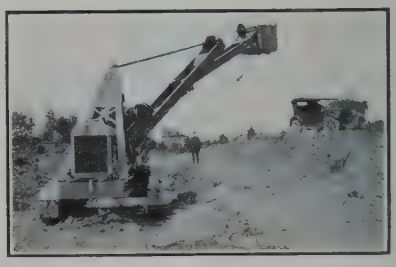
sheaves. Fewer sheaves mean greater power for actual digging and faster overhauling of cables—a faster cycle.

D-2 drag shovel dipper is built with a heavy extra arch. It takes the thrust of the boom and dipper handle and gets away from the spreading of the dipper that causes delays with ordinary dipper construction.

The long chisel-shaped reversible teeth are held without bolts or rivets in wedge-shaped sockets. This tooth is easy to sharpen and replace.

Fundom Shovel Improved

The Fundom Hoist & Shovel Company of Lima, Ohio, have developed their machine now to the point where it serves as dragline, crane, clamshell, shovel and trench hoe. The 12-ft. boom is constructed of 8-in. channels reinforced with plates and ties. The crowding mechanism is operated by double-pad special lined clutch, driving



Fundom Shovel on Road Grading Job

link chain to support shaft, which is provided with two steel, machine cut, pinions meshing with steel, machine cut, rack on dipper handle.

The machine is powered by a Fordson tractor or electric motor. It travels at 2½ mi. per hr. on treads which are 9 ft. 6 in. long, equipped with Alemite lubricating system.

The boom travels ¾ circle, traversed by worm and worm gear driven sprocket meshing with a stationary link chain provided with a shock absorber. Dipper is 1/3 cu. yd. capacity.

King F. P. Water Meter Improved

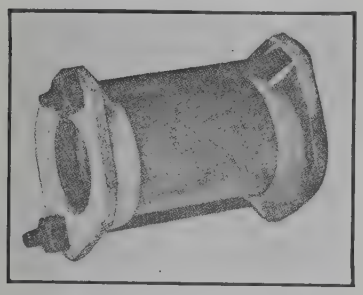
Union Water Meter Company of Worcester, Mass., recently celebrated the sixtieth anniversary of its incorporation by producing the King F. P. (frost protected) meter, which experts agree overcomes former weaknesses in design and construction.

Among the marked advances of this new meter which users of meters will immediately recognize are the position of the thrust roller, an eccentric which locks the disc chamber in place and the use of monel metal pins and lock screws which yield to excessive pressure, such as frost.

The same type of meter is also being produced with split case and is known as King S. C. meter.

Snell Improves Easy-On Threadless Pipe Couplings

The George H. Snell Company, Attleboro, Mass., announces that they are now making their line of couplings and tees of heavier construction throughout. Stronger ends combined with seamless

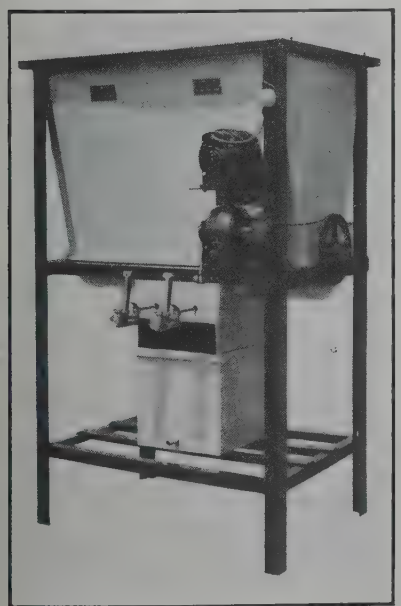


Snell Easy-On Threadless Pipe Coupling

steel tubing enables them to guarantee this new coupling to stand the strain of 250 lb. pressure. Especially recommended for repairing breaks, and making meter connections. Descriptive literature will be sent on request.

Multiple Type Dry Chemical Feed Machine

It has heretofore been necessary to install a separate dry chemical feed machine for each chemical used in a water purification plant. E. W. Bacharach & Company of Kansas City, Mo., have recently placed on the market a multiple type dry chemical feed machine that involves entirely new patented principles of operation. This device



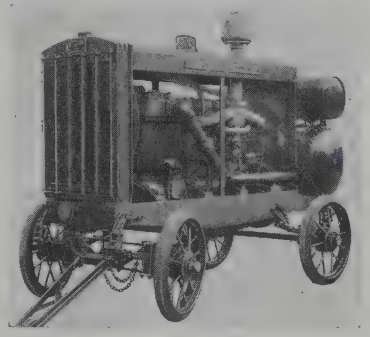
Bacharach Machine for Feeding Two Chemicals

will accurately feed any number of dry chemicals simultaneously in the same or in different amounts. The machine may also be used to feed several different amounts of the same chemical to separate points of application. The same principle of construction is carried out in building a machine for feeding three or more chemicals.

Some of the advantages of installing a single unit machine that will do the work of a number of individual devices are reduced initial cost of apparatus, decreased installation expense, saving of space and power, and less repairs and depreciation. The multiple machine may be calibrated and regulated in the same time that it takes to perform these operations on a single feed machine. The multiple feed machine is especially adaptable for use in small and medium sized water purification plants.

New Air Compressor Developed by Independent Pneumatic Tool Co.

The Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, Ill., has developed a complete line of com-



New Thor 250 Ft. Portable Compressor

pressors and contractors' pneumatic tools.

Their new unit is a Thor 250-ft. portable air compressor which, under actual test, it is claimed, delivers 210 cu. ft. of air per minute. It is equipped with the patented Rix super-charger, which enables the piston on its idle or downward stroke to compress the additional air the Thor delivers.

The Thor is direct driven. It has no clutches, couplings or gears. This design makes for simplicity and low upkeep cost. The compressor is low slung and well balanced. All working parts are easily accessible.

The bore is 7½ in. and the stroke is 7 in. The length overall is 10 ft. 10½ in. Height overall is 6 ft. 4¾ in. Width is 4 ft. The Thor compressor can be had in a variety of mountings to suit individual requirements.

The Thor 116-ft. portable air compressor, which delivers 96 cu. ft. of air per minute, will also be shown. The design and construction is similar to the larger unit.

The company's line of contractors' pneumatic tools consists of paving breakers, clay diggers, sheeting drivers, back-fill tampers, riveting hammers and chipping and calking hammers.

Littleford Bros. Announce New Tool Box

Littleford Bros., Cincinnati, O., are manufacturing an all-steel utility service tool box for public service companies and water works departments.

Littleford Utility Tool Box

They stress the safety, convenience and trailing qualities of this box.

Dimensions are: 54⅛ in. long, 36 in. wide and 36½ in. deep. The double cover can be raised from either side —it is flanged down on all sides and is absolutely waterproof. Under the cover is a large double tray for small tools. About halfway down the main section of the box is a shelf 12 in. wide and 54⅛ in. long. The side walls of the box, when opened out, form strong utility shelves.

Strong, low slung chassis cushioned on heavy helical springs, 32 in. by 3 in. rubber tired wheels equipped with heavy duty roller bearings, 1½ in. high carbon steel axle and non-collapsible drop leg are assurances of long, steady service under hard usage.

Littleford Bros., also make a large heavy duty all-steel tool box for public service and highway maintenance work. An all-steel storage box made in two sizes complete their line of tool boxes.

Light Steel Sheet Piling Devised

Wemlinger, Inc. of New York have developed a corrugated sheet pile of light weight steel which is interlocking and easily handled.

With the protection of a driving cap the sheeting may be driven by hand, air or steam without being damaged, so that it can be used repeatedly

Withdrawing Wemlinger corrugated sheeting is as simple and economical as driving it. Its light weight makes unnecessary expensive equipment and high labor costs. The sections, made interlocking by short clips, are separated without damage as easily as they are put together.

Improved Non-Clogging Centrifugal Pumps

In the last few years rapid development of centrifugal pumps for handling domestic and industrial sewage has been made by a number of manufacturers. The satisfactory handling of sewage of all kinds requires that the pump be capable of passing rags, sticks, stones, etc., without clogging and without the use of strainers. Originally it was thought that this could not be done without sacrificing efficiency. Experimentation, however, has shown that non-clogging pumps can be made to approach in performance and dependability the better clear-water pumps.

In this class of apparatus the Economy Pumping Machinery Company, Chicago, Ill., has announced three new non-clogging designs containing numerous mechanical improvements that make for longer life. These new pumps are made in capacities from the 3-in., 100 gpm. unit that will handle 2½-in. spheres to the 10 in. 5,000 gpm. pump that will pass 7-in. spheres. Pumps of all capacities are made in vertical submerged design, vertical open-shaft design, and horizontal direct-connected or belt-driven.

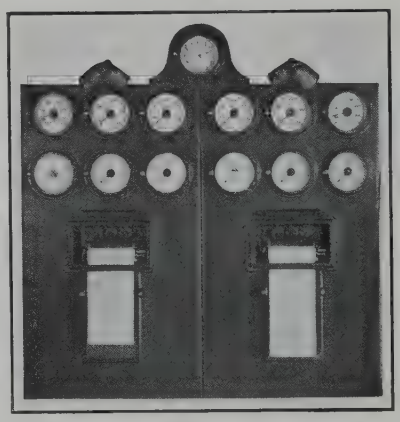
The vertical submerged type is used principally for handling sewage in buildings and industrial establishments where a self-contained unit is desired. The adaption of the non-clogging design to this type of apparatus presented a difficulty in that the impeller hub must be long enough to lock it to the shaft and to receive the countersunk nut. In the new construction the impeller hub is covered with a steel sleeve that acts as the lower journal, making it possible to extend the lower bearing close to the impeller, thus increasing the bearing life and removing all journal wear from the pump shaft. The bearing at the upper end of the shaft is a combination radial and thrust ball bearing mounted in a dustproof housing with double-nut micrometer adjustment. This adjustment makes it possible to drop the impeller assembly to compensate for wear at the impeller inlet.

The open-shaft vertical pump is designed for installation in dry pump chambers such as usually are provided in municipal sewage plants. Instead of operating in the liquid to be pumped, suction pipes are connected to a wet well or chamber. With this type of installation it is possible to elaborate somewhat on the pump design. These open-shaft pumps are of the ball-bearing type with all running bearings above the pump case in a tight grease-lubricated housing. There is provided in the shell a short renewable bearing that is used to take any shock that might occur should a brick or other heavy solid become lodged in the impeller. Adjustment of the impeller is accomplished by means of a micrometer adjusting nut at the upper ball bearing. This adjustment may be made by lifting the bearing cap without removing the coupling from the shaft.

Horizontal pumps of the non-clogging design are used for handling sewage, foodstuffs, paper stock and any other stringy or pulpy material. These pumps may be direct motor driven or belt or chain driven from any suitable power source. They are of rigid design with roller outboard bearings that carry the entire weight of the rotor, there being only a shock bearing within the pump casing.

New Control Panel Announced

The Republic Flow Meters Co. of Chicago announce their new type Republic master panel. This panel makes possible the centralized control of all pumping and storage units, regardless of their location. All records are grouped on the master panel, giving a



Republic Flow Meter Master Panel

complete survey of the operation of all hydraulic units.

Indicating, integrating and recording units can be mounted in any desired combination which will best meet the individual requirements of the installation.

Pipe Line Welder Improved

A pipe line from Jal, N. M., to El Paso, Tex., is being constructed entirely by welding, employing the metallic arc. The pipe itself is fabricated by this method in the plant of the A. O. Smith Corporation in Milwaukee and the line also employs their recently announced Smith Welded expansion joints.

In construction the 30-ft. lengths of pipe are first joined into sections of 5 to 8 lengths, usually 7, by tack welding and are then welded by "the firing line welders," the pipe being turned by tongs as the welding operation progresses. "Firing line" welders are averaging 13 completed welds per 10 hours, it is said. The sections are then

Fuson Welder Moving to New Setup

joined "by the bell hole method," in which a hole is dug for the welder, and he works completely around the pipe as it rests stationary over the ditch.

General Electric, Lincoln and Fuzon welders are on the line. This latter machine is a mobile outfit, being mounted on pneumatic tires, with standard Ford wheels.

The rod being used is the Green Surface Weldite, a product of the Fusion Welding Corporation of Chicago, as is also the Fuzon welder.

Hydraulic Power Electrolyzer Announced

The Direct Oxidation Process Corporation of Philadelphia, Penn., has recently placed on the market a new design of electrolyzer utilizing hydraulic power for the operation of the scrapers. This new arrangement superseded the previous crank and connecting rod type of drive and makes it possible to use larger, and in consequence a less number of electrode plates with a corresponding longer scraper travel resulting in a reduction of about eighty per cent of the moving parts required in former designs. The drive is conveniently mounted above the electrolyzer tank thus eliminating the extra excavation required with the previous models in which the scraper operating machinery was located under the tank. In addition, due to the more compact arrangement, the required length of the equipment for a given treatment capacity is materially reduced resulting in large savings in building costs. The design, in general, greatly increases the accessibility of the interior of the machine, facilitating maintenance and inspection.

Masterwrench Announced

Heller Brothers Co. of Newark, N. J., announce to the field a new wrench that automatically fits all sizes of pipe, bolts and nuts. They call it the Masterwrench. Every Masterwrench is made from carefully heat treated drop-forged, chrome vanadium steel. Its two parts rapidly adjust themselves to the size of the job at hand. It is self adjustable.

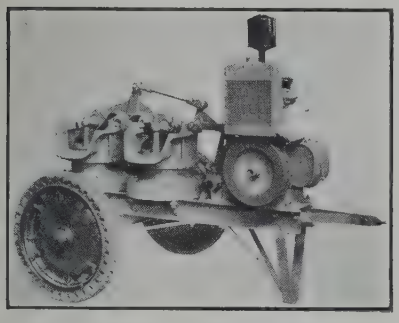
A New Double Diaphragm Pump Unit

The John Lauson Mfg. Co., New Holstein, Wis., announce a new double diaphragm three inch pump unit. A 2½ to 3 h. p. Lauson vertical radiator cooled engine furnishes the power.

Some of the features of this engine are:

Mechanically driven flyball governor enclosed in dust proof housing.

Roller bearing construction; the



Lauson Portable Double Diaphragm Pump

crankshaft is mounted in high grade heavy duty roller bearings which are lubricated from engine crankcase. This construction reduces friction and promotes smoother performance.

Heavy counter-balanced crankshaft; the crankshaft is 1⅜ in. in diameter, balanced with counter weights which reduce vibration to the minimum. A good heavy crankshaft is the backbone of an engine. Heat treated, drop-forged shaft of more than ample proportions is used in this Lauson motor.

Cam shaft; the camshaft is one piece, drop-forged, hardened and ground, and is mounted in large bronze bearings. This type of camshaft will show very little wear and will maintain correct valve action.

Oiling system; the lower base of engine forms an oil reservoir from which the oil is raised by a submerged plunger pump driven by an eccentric on the camshaft. The oil is distributed to all vital parts of engine by splash system.

Connecting rod; the connecting rod is interchangeable with Ford Model T rods.

Piston; the grey iron piston, specially designed for high speed performance is equipped with three rings.

Ignition system; high tension Wico magneto.

Hutto ground cylinder; the Huttto Method of grinding is used by 85 per cent of auto and airplane engine builders, because it positively produces a straight and round bore within tolerance limits of .0005 in. in regular production.

The units will be furnished with any of the leading makes of diaphragm pumps, mounted on two wheel cushion tire trailer or four steel wheel trucks. They will be available for distribution about June 20th.

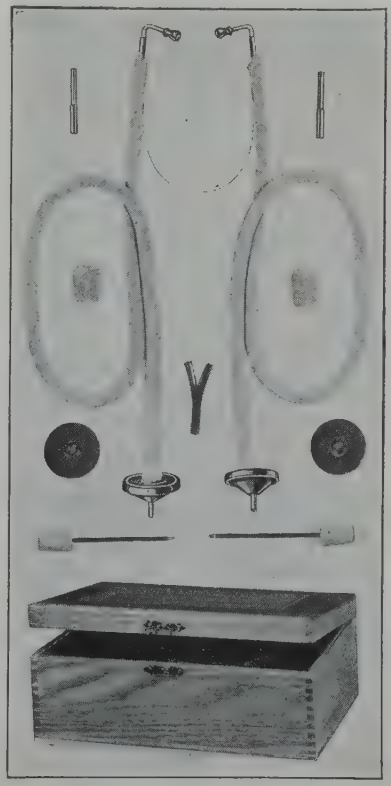
They are compact construction weighing only 775 pounds complete. The engine has a built-in gear reduction. One set of gears, which are carefully guarded operate the jack, which is of the walking beam type.

Sound Locating Tool

A new, improved Twin model Transmit-O-Phone has been developed to assist engineers, operators and mechanics in quickly and economically locating defects in all classes of mechanical devices, pipe lines, and machinery. It is manufactured by the International Metal & Specialty Co. of Berlin, N. J.

The Transmit-O-Phone is not designed to fix anything or to run a Power plant; and like any other high-class tool it naturally takes a little practice for the operator or mechanic to become proficient in its uses. It is exceedingly simple and if used with a little intelligence, the average individual can become very proficient in quickly and accurately locating defects by sound.

Use the corks on the small rods screwed into the point of each amplifier for testing fast moving machinery; where more amplification is desired, use the small round plates screwed into point of each amplifier. The corks on rods are used for clarifying the sounds in high-speed machinery.

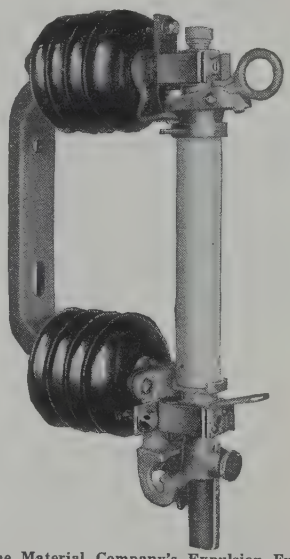


Transmit-O-Phone for Locating Defects

Should there be any problem which the operator or user of the Transmit-O-Phone may not quite understand, no matter what it may be, pipe lines, power plant machinery, motors and gears, etc., if they will drop a few lines to our main office we will be only too glad to have our engineers help them to solve their problem.

Locked Cartridge Expulsion Fuse

The Line Material Company, South Milwaukee, Wis., has brought out a new 15,000 volt, 150 ampere outdoor expulsion fuse known as their locked cart-



Line Material Company's Expulsion Fuse

ridge type. The fuse derives its name from the fact that the cartridge cannot be blown out of the contact clips under heavy short circuit conditions.

The type ED6-15M1 shown in the illustration has the lower casting arranged as a pivoted hinge for the cartridge and is so designed as to prevent the square lower terminal on the fuse cartridge from moving away from the contact clips. The cartridge is securely locked in the closed position by means of a positive catch just below the top contact clip. The catch is held by means of a bronze spring and cannot be disengaged except by pulling the ring handle downward. The top cartridge terminal is equipped with a knurled cap and the lower one cast with a guiding fin and equipped with knurled contact screw. A small L-shaped projection is fastened to the lower square terminal block on the cartridge for use in connection with a combination lift and pull stick.

The contacts are spaced on 12-in. centers, are double spring clip type, insuring ample and uniformly distributed pressure. The top contact clips are the full floating type, insuring proper alignment at all times.

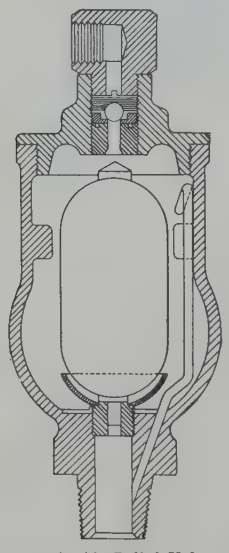
The U-shaped mounting is of galvanized malleable iron and has, it is claimed, a 20,000-volt one piece insulator at each end cemented thereon and allowed to set under steam, insuring a perfect bond.

The cartridge tube is furnished either of bakelite or fiber. The bakelite tube is provided with a special high heat resisting lining which by a special process is made an integral part of the tube. The tubes can also be furnished with an outer porcelain tube for protection from the weather. Fiber tubes are always furnished with the porcelain outer tube. These fuses are described in the company's new catalog No. 28-A.

Apco Automatic Air Relief Valve Improved

Within the last few months a new and improved automatic air relief valve has been brought out by the Automatic Primer Company, Chicago, makers of Apco Primers for centrifugal pumps.

This new air relief valve has proved useful in three different applications, namely, to centrifugal pumps, piping systems and various types of tanks or vessels. The valve is a simple device



Apco Automatic Air Relief Valve with Ball Inserted

which passes air in or out but closes immediately on liquids.

On centrifugal pumps, single or multi-stage, the valve automatically vents the pump casing of air which if not removed would prevent the pump from picking up its load. In large pumping systems where the several pump casings are connected to a vacuum tank, the insertion of an Apco air relief valve between each pump and the vacuum tank will prevent any liquid being taken over when air is evacuated from the pumps and suction lines.

The function of the valve on pipe lines in buildings or on cross country lines is to vent air from such lines whenever summits occur since air pocketed at these high points will otherwise lower the capacity of the line or even entirely block the flow of liquid. The valve serves certain types of fluid tanks and vessels in the same manner.

The Apco air relief valve is constructed of nickel plated cast bronze with a non-collapsible copper float. It is made in 3 sizes adapted to the majority of conditions. For further information on operation of this unit, write to Mr. Bradford, Automatic Primer Co., Chicago, Ill.

Agitator Drives in the Water Works Field

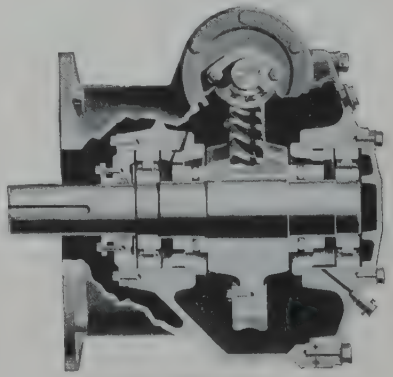
The Agitator drive speed reducing unit has found favor in filtration plants, sewage disposal plants, water purification plants and many other places where the introduction of some form of speed reducing equipment is required.

To meet these growing demands for a compact enclosed unit drive for operating mixers, agitators, paddles, etc., Foote Bros. Gear & Machine Company of Chicago, has added a complete line of vertical worm gear speed reducers. These worm reducers of the vertical type are made in two different types, either the type W commercial worm or the Hygrade worm reducer.

I X L speed reducers are fully enclosed, self-lubricating and dust-proof. Because there are no exposed moving parts they are safe. They conserve space and improve working conditions.

The vertical speed reducer of either the W or Hygrade type permit the use of standard speed motors which are less expensive than vertical slow speed motors and makeshift combinations of gears, chains or pulleys, according to the manufacturer.

The vertical worm gear speed reducers are similar to the Standard horizontal type reducer, except that a flange base is provided so that the vertical reducer is designed to lay on its side with the driving shaft at the right, the worm gear revolves in the horizontal plane and the slow speed shaft is in a vertical position. This shaft can be extended upward or downward, as the conditions may require, so that the reducer can be located under or above the machine to be driven.



Foote Speed Reducer

The construction of these reducers is similar to the Standard type reducer embodying a cast iron case, treated to prevent flaking, with a removable top cover.

Removable end plugs with oil tight stuffing glands and oil seals at each end of the worm. The base is cast integral with the case to provide suitable mounting either on the floor or hanging from the ceiling.

The worm is made of a high grade alloy steel, carbonized, hardened, ground and polished. The worm gear can be furnished either of semi-steel or bronze. Bronze is recommended by the manufacturer because of lower coefficient of friction with less heating losses and longer life.

These machines, either the Standard type W or the Hygrade type, are fully enclosed, self-lubricating units, that require little attention, except the occasional replacement of the oil.

Ball thrust bearings are provided at each end of the shaft to take up any upward or downward thrust. They are compact, noiseless, efficient, dependable units; built to meet every modern agitator problem.

Rawhide Packing for Water Works Use

This is an opportune time to call the attention of the superintendents and water works engineers to the advantages of using Rawhide packing on their pumps, both centrifugal and reciprocating, and their valve stems in all lines of work.

How Mabbs Rawhide Packing Is Shipped

A great many do not appreciate the advantages of Rawhide packing for water works use. Rawhide packing is nearly anti-frictional and its great advantage is that it is too soft, when saturated, to hold the particles of grit upon its surface, but they work back into the body of the packing, thus preserving the metal surfaces from wear and cutting. The manufacturers of

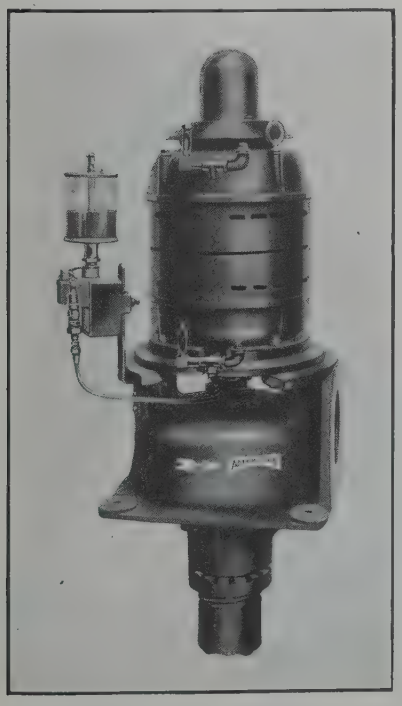
this packing claim there is nothing equal to their Rawhide packing for handling raw water or water where there is any sediment or sand in it. It is claimed that this packing has been used for twenty years by the United States Government on their hydraulic dredges.

Another comparatively recent line which has been brought out by the Mabbs Hydraulic Packing Company of Chicago, is their line of Rawhide meter washers for packing the stems of any kind of water meters. There Rawhide washers are claimed to be superior to cork washers that have been extensively used in the past. The advantages claimed by the manufacturer of these washers are that they are practically anti-frictional and never become hard or glazed and will last for years.

Small Bore Well Turbines Developed

The American Well Works announces their new 6-in. and 8-in. deep well turbines. These turbines have been built in response to a demand for a turbine to fit smaller bored wells. The deep well turbine consists of the turbine head proper, which is the driving unit, the supporting pipe, which encloses the driving shaft, and the turbine itself, which consists of the number of stages necessary for the specific requirements.

The turbine head consists of the vertical motor mounted on a rigid and compact base. The thrust bearing of the motor is designed to carry the load of the line shaft and impellers.



American Deep Well Pump

To the turbine is attached the supporting pipe, to the lower end of which is attached the turbine proper.

The turbine proper is a special style of the turbine type of centrifugal and is designed with the special features that have made American deep well turbines so reliable and efficient.

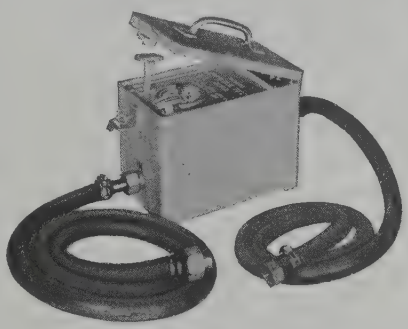
All bearings are oil lubricated by gravity feed from the surface, the gravity feed being electrically controlled.

Provision is made for complete drainage of all waste oil and water leakage and the discharge pipe is located above the floor level, which permits of easy access.

Engineering data and construction details of these turbines may be had from the engineering department of the American Well Works, Aurora, Ill.

Portable Test Meter Announced

A new portable test meter has recently been put on the market by the Badger Meter Manufacturing Company,



New Test Meter by Badger

manufacturers of water meters, Milwaukee, Wis.

This new portable test meter was developed in the engineering laboratories of this company.

The Badger portable test meter is a complete and self-contained unit of light weight, making it possible to be handled and operated by one man and with the connections set up in a practical way which permits of attachment to the service meter or when testing from hose pits in a very limited time. It will consistently and accurately check a given amount of water passing through the service meter, indicating the error either plus or minus, slow or fast on the service meter.

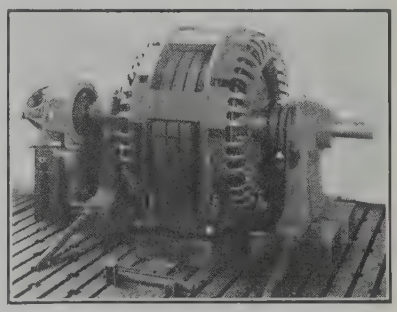
This new portable test meter makes it possible for all meter services to be checked regularly and thereby effect big economies and increased revenue, due to the increased efficiency on the service meters.

This portable test meter is a tried and proved product and has been put on the market only after years of experimental and research work in the Badger Meter Engineering Laboratory.

Structurally Fabricated Motors Announced

Fabricated steel, first used in the construction of low speed synchronous motors, is being extended rapidly by the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pa., into the high speed motors and vertical low speed motors generally used for water works pumps.

This new type of construction is particularly well adapted to building large units. A mechanical design of known and maximum strength can be produced and the construction is such that effective radial ventilation can be obtained.



Westinghouse 600 hp., 1,200 rpm. Motor for Mounting on Pump Bed Plate

Laminations are securely held between the end plates by through bolts. The end plates are further supported by struts welded between them and supporting fingers prevent loose and noisy laminations.

The advantages of adjustable speed drive and the synchronous motor high efficiencies have been secured, to a great extent, in the two-speed synchronous motor. This consists essentially of two standard synchronous motors of different speeds mounted on the same shaft and each with its own control equipment, electrically interlocked so that either unit may be operated depending upon the speed desired. The control is also arranged so that it is impossible to connect both units to the line at the same time.

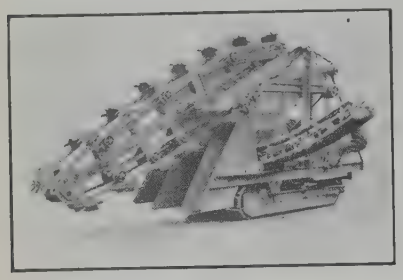
Another interesting development is the use of the reduction gears with both single speed and two-speed synchronous motors to secure the less expensive and higher efficiency high speed motor. The total cost per motor and gear unit is usually equal to or less than for the low speed motor only, and the efficiency of the unit, including gear loss, is as good or higher than for the low speed unit.

A further development has been the mounting of the synchronous motor on the extension of the gear unit pinion shaft. This method uses the engine type motor with the motor rotor overhung, tends to simplify the unit, reduce floor space required for mounting and makes the motor readily accessible.

Parsons Improves Excavator

The Parsons Company of Newton, Iowa, give the following relative to their trench excavator:

All of the main mechanism is enclosed in one gear case, gears being machine cut and case hardened. The



Parsons New Model 31 Excavator

shafting is turned and ground, mounted on anti-friction bearings, both of the roller and ball type. All gears run in an oil bath. The traction drive gears are also enclosed in an oil tight gear case. It is the highest type of construction known in the manufacturing field. It reduces the amount of friction loss as well as reducing the amount of wear and tear on the machine.

When the first machine was built it was put on actual construction work and has already gone through a grueling test period.

Ateco Hydraulic Bulldozer

The Ateco hydraulic bulldozer, recently announced by the American Tractor Equipment Company, is constructed of steel throughout, electrically welded and sturdy enough in all parts to withstand without damage the full pushing power of the tractor.

The Ateco hydraulic bulldozer consists of a heavily reinforced bowl, or blade, extending across in front of the tractor and connected to the tractor trucks through heavy, box-section side arms, one on each side of the tractor, which pivot on pin brackets attached on the outer sides of the tractor truck frames at a point where the rise and fall of the treads when working over rough ground will least affect the position of the blade. A structural steel framework is attached to the tractor through already existing bolt holes which supports at its front end a bell crank assembly. This is connected to the blade through chains, and a hydraulic cylinder with piston rod attached to the central arm of the bell crank for raising and lowering the blade through hydraulic power secured from a pump driven by the power take-off shaft of the tractor through a special 4-way valve.

Tractor Equipped With Ateco Bulldozer

The hydraulic control of the Ateco bulldozer permits the driver of the tractor to accurately raise or lower the blade instantly by means of one control lever located just in front of his seat, in the same manner that the hydraulic hoist on a dump truck is operated.

There are no parts of the Ateco hydraulic bulldozer that in any way interfere with the drawbar of the tractor; in fact, the Ateco bulldozer is frequently used in conjunction with the Ateco hydraulic dirtmover, both bulldozer and dirtmover being attached to the one tractor at the same time. When it is desired to remove the Ateco bulldozer to use the tractor for other purposes, this can be done in a few minutes by pulling the two pins locking the side arms on to the pin brackets and taking two clevis pins out of the chain links connecting the blade to the crank assembly at the front of the tractor.

The Ateco hydraulic bulldozers are manufactured by the American Tractor Equipment Company of Oakland, Calif., recently organized to build bulldozers and dirtmovers manufactured under the McMillan Patents, over 150 of which are now in use.

Trackson Announces Bulldozer

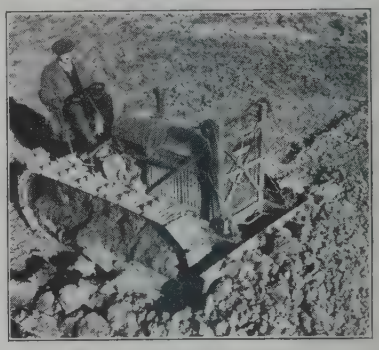
Power, speed and economy for dirt moving operations are provided by the new Trackson bulldozer, which is a recent addition to tractor equipment.

This bulldozer is manufactured by the Trackson Co., Milwaukee, Wis. It is designed especially for mounting on the Model DH Trackson McCormick-Deering crawler tractor, providing an efficient, economical unit for back-filling sewer trenches, ditches, etc., and many other similar jobs.

Like all other Trackson equipment, the bulldozer is built for heavy duty, and its extraordinary strength guarantees day-after-day reliability. The blade is mounted in such a way that the thrust or push is taken by the crawler frame, eliminating undue strains on the tractor.

The mechanical hoist used in the Trackson shovel, loader and crane is also incorporated in the Trackson bulldozer. The same principle is used in most big shovels, loading and lifting machines, a fact which attests to the efficiency of this hoisting arrangement.

This similarity of the hoisting assemblies and frames of all Trackson front-end attachments permits the ready interchangeability of these machines, which is an important advantage in that it enables the owner to use the same power unit for many different jobs. For instance, when the Trackson bulldozer has been used for backfilling a trench, the bulldozer may be removed from the tractor and the loader or shovel mounted in its place.

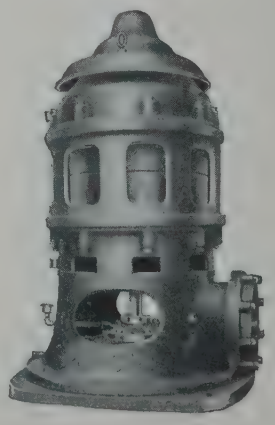


New Trackson Bulldozer

The Trackson crane is another important tractor attachment which is a time and labor-saver for water works and other public works departments. It may be used for unloading or carrying pipe, and for lifting and transporting heavy weights of all kinds.

Pomona Utilizes Water Lubrication

The Pomona water-lubricated superturbine pump, manufactured by the Pomona Pump Company, Pomona, Calif., has developed one type of turbine pump which, it is said, is especially desirable for city or municipal use because it is lubricated by water in



Pomona Westinghouse Unidrive

the well. This method of lubrication eliminates the use of all oil or grease below the surface, thus preventing contamination of the water. In addition to providing uncontaminated water, this method of lubrication forms a protective film that makes the bearings practically indestructible and prevents frequent pump troubles, officials say. Pomona pumps occupy little space, re-

quire no pit, are noiseless and vibrationless—all advantages which make these pumps especially suited to municipal use, the manufacturers believe.

Where it is desired to pump water from the well into tanks or reservoirs, it can be done quickly and economically with Pomona turbine pumps, it is stated. Water can also be delivered direct into mains under pressure; or direct into a pressure tank by automatic control, making it unnecessary for an operator to start or stop the pump.

To provide Pomona pumps for practically any conditions of pumping, the manufacturers have made them available in a variety of sizes and capacities and with either motor or belt drive. The type most widely used is the Pomona-Westinghouse Unidrive, which is furnished in all sizes up to and including 100 hp. A great convenience of this type is the electric motor built into the pump head and an automatic starting and stopping device which operates by merely pushing a button.

Wells as small as 4 in. inside diameter can be operated by these pumps and any number of gallons—from 25 to 4,500 per minute—are available, according to size of pump. If the water level recedes, it is only necessary to add additional pump column or stages.

Stover Improves Oiling System

On previous Stover engines there were from 12 to 15 oil holes or cups which required an oil supply at least once an hour, in some cases more frequently. The newest model Stover engine carries its supply of oil in a crank case and a splash lubricating system provides for its constant automatic distribution to all working parts. All hand oiling is eliminated.

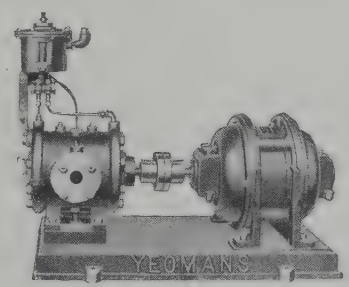
Stover engines are particularly adapted for operating such machines as concrete mixers, pumps, hoists, sawing outfits, etc., where the air is apt to be filled with dust, sand, sawdust or other foreign matter which naturally falls upon and clings to the ordinary open-type horizontal engine. The oil tight crank case enclosure on the new Stover product forestalls all trouble and wear caused from such conditions.

This new engine is interchangeable with all Stover engines of the same size, already in the field.

Literature fully descriptive of this product can be had by addressing the Stover Manufacturing & Engine Company, Freeport, Ill.

Yeomans Rotary Air Compressor

A new type of air compressor has been developed by a 30 year old manufacturer of pumping machinery, Yeomans Brothers Company, 1423 Dayton St., Chicago.



Yeoman's Newest Rotary Air Compressor

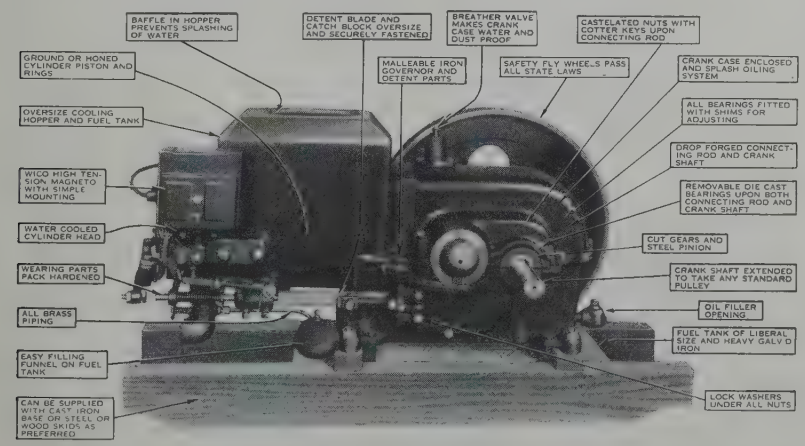
The compressor is of the rotary, multi-vane type and is quiet running, automatically oiled and direct connected to motor or other prime mover. There are no belts, pulleys, gears or valves, small space is required, wear is practically eliminated and because of simplicity of design, is light in weight.

Because of the rotary multi-vane design, the Yeomans compressor produces a continuous, nonpulsating flow of air in contrast to the pulsating flow of reciprocating compressors. This continuous air flow permits, in many cases, operation on air lines without storage tank.

No water seal is employed and the machine is lubricated with oil, so that there is no corrosion of working parts. The shaft is sealed by means of metallic packing rings with automatic spring adjustment, so that stuffing boxes are eliminated.

Automatic lubrication is effected by the use of Yeomans oil economizer, a device which lubricates only when compressor operates, and insures thorough and positive oiling at all times and eliminates the possibility of corrosion and prevents waste of oil.

The compressor is suitable for any air service in municipal or industrial work where pressure up to 50 lb. is required.


BAFFLE IN HOPPER PREVENTS SPLASHING OF WATER
DETENT BLADE AND CATCH BLOCK OVERSIZE AND SECURELY FASTENED
BREATHER VALVE MAKES CRANK CASE WATER AND DUST PROOF
CASTELATED NUTS WITH COTTER KEYS UPON CONNECTING ROD
GROUND OR HONED CYLINDER PISTON AND RINGS
MALLEABLE IRON GOVERNOR AND DETENT PARTS
SAFETY FLY WHEELS PASS ALL STATE LAWS
CRANK CASE ENCLOSED AND SPLASH OILING SYSTEM
OVERSIZE COOLING HOPPER AND FUEL TANK
ALL BEARINGS FITTED WITH SHIMS FOR ADJUSTING
DROP FORGED CONNECTING ROD AND CRANK SHAFT
WICO HIGH TENSION MAGNETO WITH SIMPLE MOUNTING
REMOVABLE DIE CAST BEARINGS UPON BOTH CONNECTING ROD AND CRANK SHAFT
WATER COOLED CYLINDER HEAD
CUT GEARS AND STEEL PINION
WEARING PARTS PACK HARDENED
CRANK SHAFT EXTENDED TO TAKE ANY STANDARD PULLEY
ALL BRASS PIPING
OIL FILLER OPENING
FUEL TANK OF LIBERAL SIZE AND HEAVY GALV'D IRON
EASY FILLING FUNNEL ON FUEL TANK
LOCK WASHERS UNDER ALL NUTS
CAN BE SUPPLIED WITH CAST IRON BASE OR STEEL OR WOOD SKIDS AS PREFERRED

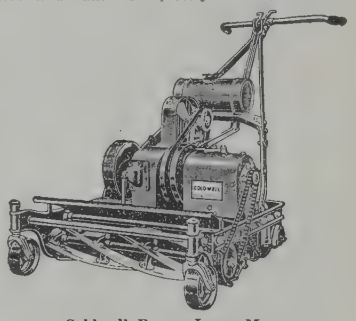
New Stover Industrial Engine

Coldwell Power Lawn Mowers

The Coldwell Lawn Mower Co., Newburgh, N. Y., give the following general specifications of their mowers for use on municipal and waterworks maintenance jobs:

General Specifications

Two-cylinder 4-cycle gasoline engine for Twin-30 and L Twin models. One-cylinder 4-cycle for L Jr. and Cub models. Water cooled with radiator and fan. Completely enclosed and automatically lubricated with oil pump. Crank shaft mounted on Timken tapered roller bearings. Tillotson automobile type carburetor. Bosch high tension magneto. Governor control. Abundant reserve power for grades. Channel steel frame on mower chassis. Full width two-section drive roller with differential. Separate clutch for drive roller and for cutting knives with individual control levers on handle. Automobile type clutches; no adjustment required. Transmission and clutches enclosed. Five blade cutter. Roller bearings throughout. Alemite-Zerk force feed lubrication. Simple and economical in operation and thoroughly dependable. Grass box, also riding sulky may be had as extra equipment.



Coldwell Power Lawn Mower

Coleman Sewer Rod Point

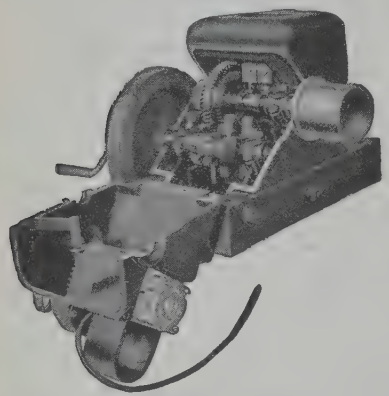
Allen J. Coleman of Chicago has developed a sewer rod point that will roll its way through stoppages and around bends. It is constructed of two roller wheels, rolling at right angles to each other. This new article, the manufacturer states, has been tested out and found to be an efficient tool.

The manufacturer also announces an improved lead point runner. The clamp is furnished with pouring funnel. It has a long fibre solid core and two braided jackets of high heat resistant, strong yarn. The foot plate is formed so as to hold clamp in place on pipe until asbestos rope is drawn tight and locked by lever clamps.

New Portable Engine Has Many Interesting Features

A new line of gasoline-kerosene engines in ratings from 1½ to 7½ hp. recently announced by Fairbanks, Morse & Company of Chicago, incorporate a number of interesting features. While the most radical departure from previous construction is in the all-enclosed self-oiling feature, the new engine is quite different in appearance from other small engines of its type.

The 1½ hp. rating, which is a size



Removal of Two Bolts Permits Opening Enclosure of the Fairbanks-Morse Engine and Exposes All of the Working Parts. Two Speed Arrangement of Pulleys Is Also Shown

used in a wide diversity of drives, such as portable pumps, air compressors, generator saws, grinders, polishers and similar uses, is the most interesting development in the new line. It is less than 16 in. high, 22 in. long and 19 in. wide and weighs 150 lb.

Two pulleys are provided, one of which operates at the engine speed of 1,500 r.p.m. and the other at 750 r.p.m. There is also a mechanical regulator which permits slowing the engine down to 1,100 r.p.m. with, of course, proportionate reduction in horsepower. With the two pulley speeds and the speed regulator it is possible to meet the requirements of almost any type of drive.

An important feature about the new 1½ hp. unit is its simplicity in design. There are said to be 25 per cent less parts than in previous engines of this size. Unit construction throughout makes the cylinder, water hopper, crankcase and bearing supports for both crankshaft and camshaft integral parts of the cylinder and base casting. The engine, with the exception of the magneto, can be entirely assembled on this casting.

Complete protection from dirt, dust, rain and snow is afforded through the fully enclosed feature. By the removal of only two bolts, all working parts, such as the crankshaft, camshaft, bearing, etc., are open to view and inspection.

Removal of eighteen bolts completely dismantles the entire engine.

Self-oiling is accomplished through a special lubricating system which literally drenches all working parts in oil. No grease cups are required.

The base casting serves as an oil reservoir. The bearing caps have caps to collect the oil which drips from special baffles located directly above on the crank case cover.

One of the special mechanical refinements is the method by which leaking of oil is prevented. Felt retainers on the crankshaft and camshaft—return oil grooves on these shafts—and a special crankcase breather eliminates all possibility of leaking oil. The crankcase breather, further, does away with compression in the crankcase. Instead of forcing the oil out at the gaskets, the special breather sucks in all oil collected at the gaskets by maintaining a vacuum within the crankcase.

Improved Speeder Shovel-Crane Announced

The Speeder Machinery Corporation, Cedar Rapids, Iowa, manufacturers of ½-yd. full revolving, convertible gasoline shovels, introduced and showed for the first time at the road show, the improved Speeder, model B-3, much faster and more powerful than previous models.

The improved Speeder, model B-3, has a hoist line speed of 180 ft. per min., a swing speed of more than four revolutions per minute and a travel speed of 1½ actual miles per hr. in high gear, and .55 mile per hr. in low gear. In low gear the machines will climb a 35 per cent grade.

The patented Speeder direct cable crowd is used. The working principle is the same as in previous models, but it is improved in view of the fact that two short cables rather than one long cable is used, thus necessitating the replacement of a short cable rather than a long one in case of breakage. The speed of the crowding action also has been increased.

Among other improvements found on the improved Speeder model B-3 is a greatly improved ultra-positive steering mechanism that permits sharp or gradual turns under most adverse conditions; heavier construction throughout; electric lights and starter as standard equipment; a new style steel cab; six carrier trunnions for the upper body rather than four, as in previous models, and a motor with 4¼x5¾-in. bore that develops full 53 hp.

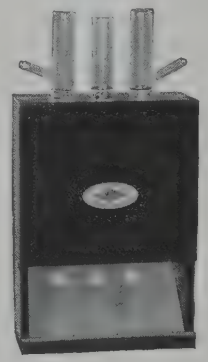
The improved Speeder, model B-3, as a shovel has for standard equipment a boom 18 ft. in length and as a crane carries either a 30 or 35-ft. boom and the working load is 10,000 lb.

Further information may be obtained from the Speeder Machinery Corporation, Cedar Rapids, Iowa.

Model B-3 Recently Announced by Speeder Machinery Corporation

New La Motte Equipment

La Motte Chemical Products Co., McCormick Bldg., Baltimore, Md., are now putting out all standards for water analysis in closed Nessler tubes with



La Motte Colorimeter for Nessler Tube Comparisons

polished tops and bottoms. The tube is filled through a side arm which is then sealed off, preserving the standard from contamination of any kind. Standards for color, nitrogen, chlorine, total iron, nitrite, nitrate, ferrous iron and manganese are available.

This special colorimeter is 7 in. long, 4 in. wide and 9 in. high. A piece of etched glass is placed directly below the bottoms of the tubes, and below this is a mirror set at an angle of 45

deg. An open Nessler tube containing the test sample is placed in the central hole and two consecutive standards in the holes on either side. Holding the upper ends of the tubes toward a source of daylight, the comparison is made by looking into the mirror. The colorimeter should be used in all comparisons with the sealed Nessler standards.

A complete new series of indicators has been developed to cover the pH range 9.6 — 13.6. These new indicators are especially useful for pH control in water softening.

Large Collapsible Swimming Pool

A portable collapsible swimming pool made of a new and almost indestructible Wunder cloth is one of the latest products of Hill-Standard Co. of Anderson, Ind.

The pool when set up is 40 ft. long, 10 ft. wide and 57 in. deep, holding 12,100 gal. of water. It is easily trucked to any point, and quickly set up and taken down. Angle iron supports keep it rigid. The Wunder cloth wall laps smoothly over the iron top rim and down, being laced to the top rim. Bathers are thus fully protected from all metal.

This new pool has a variety of uses. It is already in use in Eastern tourist camps. It is equally desirable for summer camps, groups of summer homes, near the water as well as inland. Its advantages will be appreciated for carnivals, amusement resorts and beaches, where beginners learn before going into the lake or ocean.

It makes fine provision of bathing facilities in parks, recreation grounds and clubs lacking permanent installations. It is also adaptable as a temporary sectional municipal pool. The low cost brings it within reach of many institutions which have had to do without pools.

It is claimed for this new pool that it is practically non-crackable, being protected by a finish in a new special process which holds the flexibility in exposure to all weathers. The pool is fully described in the new Hill-Standard water sports catalog, a copy of which will be sent free on request.

Hill-Standard Portable Swimming Tank

New Universal-35 Developed

The Universal-35 is a ½-yd. capacity machine, built by the Universal Crane Co., Lorain, O.

It is mounted on a two-speed center drive crawler. Speed changes and crawler steering are controlled from the operator's position, regardless of the position of swing of the turntable.

Universal-35 Two-Speed Crawler

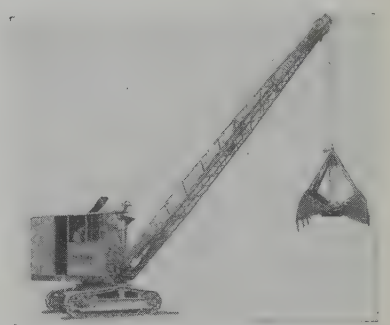
The superstructure proper is of the same design and construction as has been built for the past several years as the Universal Truck Crane. The superstructure can be mounted on either the two-speed crawler or a 5-ton motor truck chassis and is readily transferable from one to the other.

The boom equipment offered on the Universal-35 consists of crane booms 16 to 56 ft. long, ½-yd. center drive shovel, backdigger booms, clamshell and dragline bucket equipment and skimmer. All boom equipment is readily interchangeable.

New Orton ⅝-Yd. Convertible Shovel

One of the developments in shovel design by the Orton Crane & Shovel Co., Chicago, is their model A convertible ⅝-yard shovel. Its light weight, small over-all clearances and high mobility make it particularly suitable for excavating and grading contractors, material yards, industrial plants and similar applications.

Chief among the features of the Orton model A machine are the well balanced design, the scientific distribution of material, the use of alloy steel for all power shafts and gears, and the extension of cab so that the work can be seen from both sides of the operator's position. These features contribute greatly to speedy operation, and the sturdy construction insures a machine of endurance. Strength and rigidity of the base are obtained by building it of rolled plates and shapes which are thoroughly riveted and electric welded. The use of structural steel combines lightness with uniformity of material. Electric welding gives the necessary rigidity for supporting shafts and bearings, and for withstanding operating strains.



Orton Model A 6-ton Crane Equipped with Orton ½-Yard Excavating Clamshell Bucket

Flexible crawling treads of the spring type absorb shocks and protect the operating mechanism from undue strains. The springs distribute the weight of the machine uniformly over the treads so that it is not concentrated when the machine travels over uneven ground, logs or other obstructions. The treads

are self-cleaning and will not clog with loose dirt or stones. The model A can also be furnished with road wheels or for mounting on standard auto-truck chassis.

All of the power shafts are made of alloy steel, and are turned and ground. Each power shaft is in a horizontal position, and can be removed without interfering with any of the others. Interchangeable phosphor-bronze bushings are provided for all bearings. Gears are made of special heat-treated alloy steel, and all spur gears are cut from solid blanks.

An abundance of power is provided by the heavy-duty 53-horsepower Hercules motor, which is provided with an electric starter as standard equipment.

The model A can be furnished with shovel, crane, dragline, ditcher or skimmer attachment, and can be changed from one to any other in the field in less than two hours, it is claimed.

A feature of the shovel, the manufacturer states, is the positive crowding action, the full power of the engine being transmitted directly to the digging edge of the dipper by the patented gear-driven crowding device. The shipper shaft is driven by a slip friction adjusted to release before the main clutches slip or the engine stalls. In operation, the crowding clutch is thrown in completely, and a constant thrust is maintained on the dipper, the slip friction acting to absorb shocks and jars, and to prevent killing the engine or transmitting undue strains to the power clutch. The entire crowding mechanism is integral with the boom, thus facilitating changes to other attachments.

The model A crane has a lifting capacity of 6 tons at a 12-foot radius, and, when equipped with a standard 30-foot boom, handles a ½-yard bucket throughout its operating range. Booms 35 or 40 feet long can be furnished for hook operation.

The patented Orton T head on the ditcher attachment gives maximum pull back when the dipper stick is nearly horizontal, and minimum pull when the scoop is in a digging position. This arrangement affords great digging power and also serves to snap the scoop back quickly when dumping. Two drums mounted on the boom, one on the top leading to the hoist drum and the other leading to the scoop, eliminating a sheave at the scoop, and give straight, direct pull.

The dragline has a 30-foot, lattice-type boom, and the fair-leader slides so as to give the most direct lead possible to the drum, being carried on a bronze-bushed, cast-steel lead sheave, with guard sheaves properly balanced so as to produce a minimum amount of wear on the cable. It handles a bucket with a capacity of ½ cubic yard.

The model A skimmer is provided with a steel boom, from which the scoop is suspended by means of bronze-bushed steel rollers. It has an effective length of travel of 11 feet, and the scoop has a capacity of ½ cubic yard, with a width of 30 inches, although special widths can be furnished.

New Dorr Equipment in Sewage and Water Works Fields

The Dorr Company of New York has introduced within the last year or so three new equipment units for the more effective mechanical solution of such frequently met sanitary engineering problems as coarse screening, grit removal and washing, and agitation or mixing. Each new unit is allied in a sense with existing Dorr sanitary equipment in that it precedes and supplements the Dorrco screen, Dorr traction clarifier and Dorr sewage digester.

The Dorrco bar screen consists essentially of two main parts:

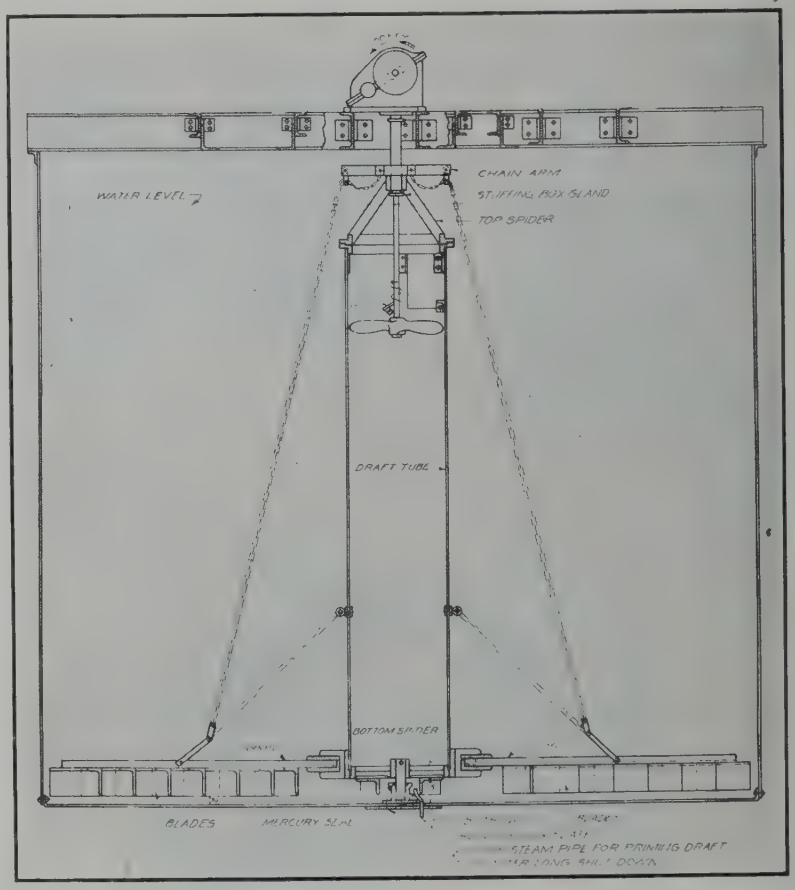
1. The stationary bars forming the screen.

2. The cleaning mechanism for removing the screenings which are deposited on the bars.

The straight bars forming the screen are similar to those used in plain bar screens, and usually are ¼-in. by 3-in. bars, placed in the channel at an angle of 60 deg., the opening between the bars depending on local conditions.

The cleaning mechanism consists of raking mechanism with supporting frame, drive mechanism with supporting frame, and rake scraper for removing the screenings from the raking mechanism.

The Dorr Detritor is an automatic, self-cleaning grit chamber, for general use in place of the conventional grit settling troughs at sewage disposal plants. The name Dorr Detritor has been taken from the word "detritus," which is usually used to refer to the inorganics in sewage. This machine performs all of the functions of the grit settling channels and in addition automatically collects and washes the grit, delivering it finally in a clean, dewatered condition to a suitable receptacle.



Sectional View of New Dorr Impeller Agitator

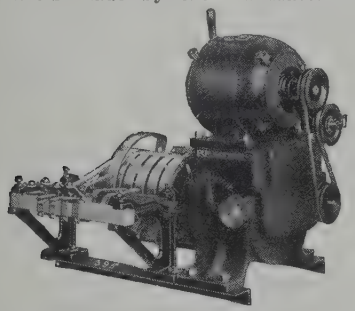
The Dorr Impeller Agitator is the most recent equipment development of the Dorr Company in the water works field. This unit is designed to give that type of efficient mixing which is so important in the chemical softening of hard waters and the chemical dosing

of turbid waters. A feature of considerable importance is its ability to turn over a large volume of water at a velocity which does not break up flocs.

Reco Traffic Control

The accompanying illustration shows one type of Reco variable control which has been the "Mechanical Traffic Officer" of a great many of the Stop and Go signals throughout the U. S. A. since automatic traffic regulation was adopted.

The adjustment of this control as well as that of other types of variable controls made by the manufacturers,



Reynolds Mechanical Traffic Officer

The Reynolds Electric Company of Chicago, is of the thumb screw type, permitting the regulation of the speed of the drum during one-half of a revolution. This enables the officer in charge of traffic to regulate east and west or north and south traffic to suit the peculiar conditions of the intersection.

Assuming that the traffic control is set for 30 seconds north and south or one cycle in 60 seconds, the thumb screw enables changing to either 40 to 20 seconds of any point in between or vice versa. In other words, a 33⅓ per cent variation faster or slower in either direction can be secured by this feature of the Reynolds variable traffic control.

The Reynolds Electric Company also manufacture flashers for blinkers, flashing beacons, stop or warning lights, airport lighting needs, alarm signals, etc. Information bulletins are furnished cheerfully upon request.

Fusee Screw Water Level Recorder Improved

Julien P. Friez & Sons, Inc., of Baltimore, announce the development of the Air Fusee screw water level recorder. The instrument records water level variations on a continuous roll and will operate continuously for 60 days without attention.

Outstanding features claimed for the instrument follow:

Simplicity, the design embodying a minimum of moving parts without delicate mechanisms.

Ease of operation, with dependability and accuracy of performance under adverse conditions.

Fusee paper drive, which avoids the complicated system of rollers common to other designs and provides means of adjusting the paper drive to eliminate time errors.

Record placed directly on original roll, before the paper has had a chance to shift laterally or otherwise alter its original condition.

Endless screw pencil drive, so constructed that the pencil carriage will reverse at either end without changing the rate of lineal motion at the point of reversal.

Positive drive float wheel, which eliminates all gage height errors due to slipping or improper seating of the float cable.

Jewelled clock, weight driven, with dial and hands for indicating time, connected to driving mechanism by universal joint and removable without tools.

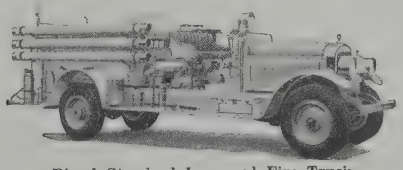
Easy removal of sections of chart, when records covering short intervals of a day or week are desired.

The distinctive feature of the recorder, and that from which it received its name, is the slightly conical, spirally grooved pulley, known in clock making as a "fusee," the function of which is to drive the paper at a constant lineal speed.

Pirsch Improved Fire Truck

Peter Pirsch & Sons Co. of Kenosha, Wis., announces an improved 1,000-gal. fire pumper.

The motor, transmission, axles, rotary pump, chassis and fire equipment design and construction is improved, evolved after years of study of fire department problems. Great strides have been made in motor design since the



Pirsch-Standard Improved Fire Truck

first pumpers were built. The motor in this 1,000-gal. pumper delivers its full rated capacity of 1,000 gal. at 120 lb. per pump pressure from suction. The Pirsch-Standard 1,000-gal. pumper delivers its rated capacity from suction at 120 lb. net pump pressure at 1,350 rpm. of the motor or only 67 per cent of the maximum, which means a reserve of 33 per cent. When operated at close to its safe maximum operating speed it has pumped 1,312 gal. of water at 127 lb. net pump pressure from suction.

The truck comes fully equipped. It has a rotary type pump with stainless steel shafts, synchronizing gears, positive dependable relief valves, also auxiliary force feed oil pump, built in, which lubricates all moving parts requiring lubrication.

Pressed Brick Important Item

The new Howard's Bend plant of the St. Louis, Mo., water works system at present includes a group of buildings consisting of high and low pressure engine houses, boiler house, coal receiving house, filter house, head house, coagulant house, and two gate houses at the settling basins.

The interior of these buildings necessarily must be of the most scrupulous sanitary nature. The architects, Messrs. Study & Farrar, solved the problem so far as the wall surface was concerned by the use of enamel brick. In order to avoid the glare of white enamels, the Hydraulic-Press Brick Company of St. Louis developed especially for the architects and under their direction, a soft special shade of gray which provides to be both pleasing to the eye and attractive in appearance, practically eliminating glare. These great wall expanses, however, are not left without a relieving trim and, for this purpose, the company furnished the architects with a transparent speckled buff enamel brick which is used around all windows and doors, and not only for a base but also for all horizontal and vertical trim lines. It may be interesting also to know that the pits in both the high and low pressure houses, where the big pumps are installed, are lined from top to bottom with gray enamels.

New Type Hydrant Devised

Shand and Jurs Co. of Berkeley, California, have developed a new hydrant especially applicable to climates where freezing does not occur. All of the operating parts are in the head. Instead of shutting the water off at the base of the plug it is allowed to be in the head continually and to enter the hose connection by opening a valve which closes that connection. The valves operate directly on the hydrant hose connection passage ways.

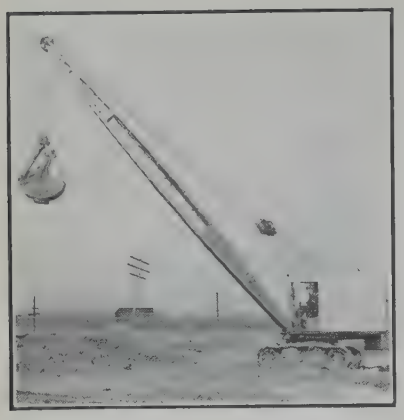
The hydrants are made with various sized openings.

Lorain 55, a New 1-Yd. Machine

Recent developments in the excavating and material handling fields have created a distinct need and demand for a 1-yd. machine of the calibre, construction, speed and design of the 1¼-yd. Lorain-75, according to the Thew Shovel Co., of Lorain, Ohio.

All the advantages of Thew Center Drive principle, as proven by the Lorain-75, direct power, rugged strength, high speeds, smooth, positive three lever control, and high standards of construction and materials are duplicated in the new 1-yd. Lorain-55. All three power shafts can be engaged at once, giving three simultaneous operations, independently controlled.

The 1-yd. Lorain-55, while it incorporates the successful design features



Lorain 55, Thew's New 1-Yd. Machines

of the Lorain-75, is not a machine "cut down" or "built up" from other capacity units. Rather, it is an entirely new superstructure designed and built throughout of a size, strength and weight to most efficiently handle a 1 cu. yd. struck measure.

On bin charging, material rehandling, stock-piling, and on large sewer clamshell excavations and backfilling, the Lorain-55 offers an improved 1-yd. crane.

Due to an easily adjustable slip friction on the holding drum, the Lorain-55, as a clamshell, is operated by only two hand levers and two foot pedals. Booster bands on the hoist clutch controls insure easy, responsive operations.

Harnischfeger Builds Side Wheel Trencher

A new side wheel trenching machine, recently added to the line of excavating equipment manufactured by Harnischfeger Corporation, Milwaukee, promises to be an exceptionally popular model with public utility companies.

The Pacific Gas & Electric Company, San Francisco, Cal., has just purchased one of the new wheel type machines for use on a 76 mile pipe line job near San Francisco. It is averaging approximately 1,300 ft. of trench per eight hour shift—cutting to a depth of 4½ ft. and 28 in. wide, the manufacturer states.

A side wheel trench of this type has several distinct advantages for city work. The cutting wheel, being mounted at the extreme left hand side of the machine, permits cutting exceptionally close to a line of telegraph poles or close to the street curb. The side wheel feature is also a valuable aid when cutting trench close to the edge of a highway. The cutting wheel projects 2 ft. beyond the outer edge of the crawler, making it possible for the entire traction to remain on the hard road or pavement—thereby avoiding the expense of planking up a low side.

The machine is equipped with a 55 hp., heavy duty Waukesha engine which consumes approximately 35 gal. of gasoline per eight hour shift. The wheel has a cutting range of 20 to 28 in. in width and can dig trench to a depth of 5 ft.

Kupferle Tests Hydrants

Recent tests on the new Kupferle fire hydrant shows it is to pass all requirements of the Associated Factory Mutual Fire Insurance Companies.

This hydrant is manufactured by the John C. Kupferle Foundry Co. of St. Louis, Mo.

The barrel is made in three sections. The top section embodies a stuffing box for the operating stem and serves as a cap for the hydrant. The middle section is a cylindrical casting provided with a flange on each end and with two outlets spaced 90 deg. apart near the upper end. The outlets are provided with 2½-in. bronze hose nipples, which are threaded and pinned in place.

The seat ring casting is of bronze and is threaded into the upper part of the inlet barrel section.

Two pair of vertically extending bronze guides located diametrically opposite each other are cast on the upper part of the seat ring casting to guide the valve mechanism.

A 5/16-in. drain hole is provided in the seat ring opposite the annular groove in the upper part of the lower barrel section, this hole being closed by the drip valve when the hydrant valve is in the open position. The lower end or face of the seat ring is beveled at an angle of 45 deg.

The diameter of the waterway through the seat ring is 5½ in.

Capillary Comparator

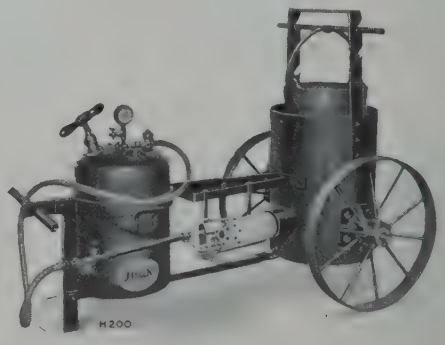
Eimer & Amend of New York announce the development of a comparator for hydrogen ion determinations. The Hellig comparator uses permanent, non-fading glass standards, but the glasses are rectangular plates and are enclosed entirely in a glass housing, acid and dust-proof, thus forming a convenient color scale. The capillary tube, which contains the solution to be tested, together with the indicator, is held by a metal rider which moves along the color scale. This rider has a milk glass back for diffusing the light, an opening in front for securing the proper color field, and two openings at the margin for reading either the horizontal or the vertical pH valves, depending on how the rider is placed on the scale. Each color scale is marked horizontally and vertically with the corresponding pH value for readings in either position of the apparatus. The color comparison may be made and the pH value scale can be read from one point of observation. As the color fields are close together a very good match is obtained. The metal rider can be used with any of the glass color scales.

This outfit is very handy for measuring hydrogen ion concentration for minute quantities of test solution, only one drop being required.

New Hauck Lead Melting Furnace

The new line of Hauck combination melting furnace and portable torch equipments, on legs and on wheels, are designed for heat control, a new and exclusive Hauck feature. Instant and positive heat control under the pot is secured by the new slide-rail burner construction. For full heat, simply push burner forward on slide-rail; for less heat, pull burner away from furnace. Each size of burner gives an intense,

P. & H. Side Wheel Trencher Recently Developed



Hauck Slide Rail Lead Melting Furnace

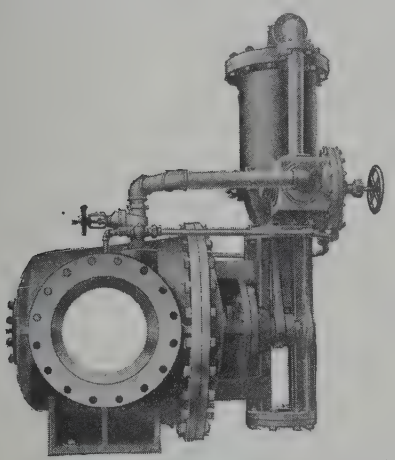
reddish blue, clean and steady flame from 1,600 deg. to 1,800 deg. F. with no smoke.

Write Hauck Mfg. Co., 141 Tenth St., Brooklyn, N. Y., for bulletin No. 101 illustrating and describing the above lead melting combinations.

Outboard Type Valve Announced

The advent of the centrifugal pump in pumping stations introduced some interesting problems to the waterworks field. Particularly were engineers in this field concerned with check valves. Several different styles of check valves were tried to meet varying conditions.

The Automatic Cone Valve Company of Chicago, have developed valves which have the inherent features that



Automatic Cone Valve Company's Outboard Type of Valve Recently Developed

are of utmost importance to the operating engineers. The fact that when the cone valve is in full open position, the waterway is similar to a piece of pipe and reduces frictional resistance to a minimum. This question of friction plays a very important part in the design and layout of plants and pipe lines; wherever obstructions are eliminated the increase in pressure can be evaluated on a dollars and cents basis which reflects itself into increased efficiency.

The Automatic Cone Valve Company first produced what they now term the Inboard type of valve which first made its appearance at the American Waterworks Convention in Chicago, Illinois, during June of 1927. At that time, the engineers were very much impressed by its quick and easy operation. Later developments naturally tended to simplify construction and improve the operation. The accompanying picture very clearly shows the circular waterway without obstructions. All the operating mechanism is "outboard" and can be inspected without interfering with operation. In fact, every part of the hydraulic mechanism can be removed and replaced without shutting down the pipe line.

The cone valve has the inherent advantage of having a plug which is mounted in bearings and revolves freely on these bearings during operation without the seats coming in contact with any other metal. It is a surface of revolution fitting into another surface of revolution, and therefore, can be lapped into its own seat, making the tightest valves known. For operation in gritty water, the rotation of the plug has a selfcleaning effect. The accompanying picture shows the automatic cone valve which is composed of two distinct mechanisms. The hydraulically operated cone valve and the control mechanism which properly times the opening and closing of the valve eliminate shock and water hammer. Cone valves are made for electrical, manual or hydraulic operation. All automatic cone valves are hydraulically operated. Manually operated and electrically operated cone valves are very adaptable for use as stop valves controlling distribution systems where pipe diameters are of large size.

The automatic cone valve is so designed that it does the double duty of both a stop and check valve. This operation is accomplished by installation of the control valve having two Pitometer connections through the valve proper which register the condition of flow against the diaphragm unit control valve. The movement of this diaphragm distributes the power water to the proper side of the hydraulic cylinder which in turn opens or closes the cone valve itself.

New Laboratory Media

In the not so distant past much importance was ascribed to the spore-forming anaerobes as indicatory of sewage pollution. Today, however, the chief interest of the water bacteriologist in the spore formers is due to their interference with the presumptive test for Esh. coli. Spores may persist for indefinite periods in polluted waters. Their presence, therefore, does not indicate recent or dangerous pollution, nor does it distinguish between the decomposition of animal and plant wastes.

Bacto-Brilliant Green Bile and Bacto-Brilliant Green Bile, 2% Special have been developed by the Digestive Ferments Company, Detroit, Michigan, cooperating with Committee No. 1 Standard Methods of the American Water Works Association, as two dehydrated culture media for the purpose of eliminating the confusion resulting from non-confirmable presumptive tests. Both the dye and bile act as inhibitory agents, preventing the development of the spores, but permitting the growth of the gram-negative, non-spore forming, lactose fermenting organisms.

Bacto-Brilliant Green Bile is prepared according to the formula of Muer and Harris. The dehydrated medium has been used with satisfaction by many sanitarians. Bacto-Brilliant Green Bile, 2% Special, is made up to contain a reduced content of bile with the dye present in a 1:75000 concentration. This medium also is very satisfactory for the presumptive test.

The use of these media in the water bacteriologist's laboratory is still a tentative procedure. Much study has already been, and is still being, undertaken to determine the value of the inhibitory action. Results would seem to indicate that both of these media are of distinct value, especially with certain types of waters.

Further information on how to manipulate the tests will be furnished by the Digestive Ferments Co., of Detroit.

The Northern Valve Announced

The Northern Pump Company of Minneapolis, Minn., describe their newest development, the Northern Valve. Northern double packed valves are of the stop cock type, packed both at the top and the bottom, a design and construction completely covered by U. S. patents. This valve was formerly known (1921 to 1928) as the Victory FcH double packed valve, made by the Victory Manufacturing Company of Niles, California. Ordinary makes of plug valves (stop cocks) have failed to attain wide general use because of the inherent tendency of plug valves either to stick or to leak, according to the manufacturer.

Northern double packed valves have stuffing boxes located at the top and bottom of the plug, the two points where leakage could occur, and can't keep leaking. They cannot stay stuck. Slight tightening of the bottom packing gland usually will loosen a stuck plug, but if this should fail, a sharp blow on the bottom will certainly jar loose a plug which has become stuck tight.

Northern double packed valves are lubricated by a simple but positive method, insuring correct lubrication of valves used in air and gas lines which carry no liquid and are normally dry. Alemite fittings are installed on valves which require lubrication, at the request of the purchaser. Otherwise the openings will be closed by plugs, interchangeable with the Alemite fittings.

The valve ports are regularly rectangular in shape, of practically the same area as the corresponding pipe. These regular ports are called Smoothway. If the valve is required for throttling service, Diamond ports may be had at the option of the purchaser. Three-way and four-way Northern valves are available, in the Smoothway type, also a line of stream jacketed valves. For further information, address Northern Pump Co., Minneapolis, Minn.

Hydraulic Oil-Power Jacks for Hydraulic Field

For general utility in the water works field the Blackhawk Manufacturing Co., Milwaukee, Wis., announce their hydraulic oil-power, gauge-equipped jacks. These jacks are in favor wherever accurate maximum loads or strength of material must be tested easily and economically.

Jacks with gauges are used to determine weights of loaded trucks; strength of concrete or vitrified pipes; testing concrete beams for bending or shear; sinking piles to pre-determined loads; press work and many other uses where total weights of load, or pressure per square inch is desired.

Blackhawk Jacks can be equipped with gauges of any size or tonnage and with graduations to suit the needs for industrial, laboratory and experimental tests.

Gauges are individually hand calibrated to conform to the Bureau of Standard Specifications for Hydraulic Gauges which means that they must be correct within 2 per cent plus or minus of the reading indicated.

Due to lightness and compactness most Blackhawk jacks can be handily operated by one person on any job. They have double utility as when not in use for testing, the gauge is easily removed, a half inch pipe plug inserted and the jack used for any other lifting work.

New Fire Pump Chlorinator

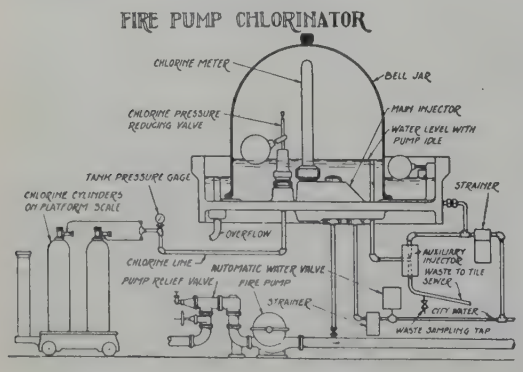
In co-operation with representatives of the fire underwriters and the New York State Department of Health, Wallace & Tiernan have developed a new fire pump chlorinator. The equipment was designed to meet conditions in those industrial plants where it was found absolutely necessary to maintain a cross connection between the fire system from a secondary source and the public water supply. Installations in New York State are in conjunction with factory mutual type double check valve.

The chlorinator used is the standard Wallace & Tiernan vacuum type solution feed equipment. A small auxiliary injector is provided which is operated continuously from the city water system, discharging to waste a small quantity of chlorine solution (1 to 2 lb. per day). Operation at this low rate keeps the chlorinator in readiness at all times for emergency use when the fire pump is put in operation. Water from the fire system supplies the main injector of the chlorinator and automatically feeds chlorine to the fire pump supply at a predetermined rate to assure sterilization of the water. This rate of feed is constant. The chlorinator is set in accordance with specifications of the state board of health. The chlorinator is not sold for installation except under conditions approved by the state board of health.

In practice the operation of the auxiliary injector is checked daily by testing for chlorine in the water discharged to waste. Weekly tests are required in accordance with the requirement of the state board of health. Careful records are kept of the operation of the fire pump chlorinators.

This equipment promises to be a practical solution of the difficult health problem of assuring protection against local cross connections within industrial plants where of necessity a secondary fire water system must be provided.

For further information write to Wallace and Tiernan of Newark, N. J.



Wallace & Tiernan's New Fire Pump Chlorinator

Automatic Pressure Controller

The Electric Controller & Mfg. Co. of Cleveland, Ohio, has developed altitude and pressure regulators for automatic control of pressures and liquid levels which are applicable to the water works and general municipal field.

E C & M automatic pressure control equipments are used with motor driven apparatus for the automatic regulation of water, liquids, air or gases.

These equipments are made in two types designated as altitude regulators and pressure regulators. They differ only in the design of the regulating gauge.

Altitude regulators include a gauge which registers pressure or altitude with a high degree of accuracy. These gauges are practically frictionless and the pointer will respond accurately to extremely small variations in pressure. Altitude regulators are, therefore, suitable for controlling pressure systems where liquid levels of air pressures must be maintained between extremely close limits.

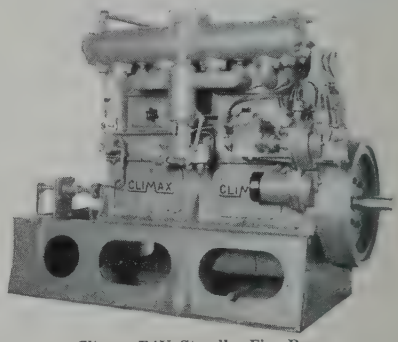
An E C & M altitude regulator panel automatically controls two pumps that discharge into the same tank. This is a very interesting application of the E C & M altitude regulator in that it has many features such as should one pump not deliver sufficient water, the other pump will automatically be started and should one pump become disabled so that it will not maintain the water within the required limits, the other pump will automatically start and the disabled pump will be cut out.

It may also be used in another interesting way in that the pressure of a gas system may be maintained between predetermined limits. The company recently figured on using this regulator in connection with a gas booster pump that was driven by a direct current adjustable speed motor. Should the pressure fall below a certain value, the altitude regulator automatically increased the speed of the motor sufficiently so as to increase the pressure.

Standby Fire Pump

The Climax Engineering Company of Clinton, Iowa, have developed an engine for fire standby service which they call their Model R4U Uunderwriters' Engine.

This engine has been approved by the Underwriters' Laboratories for fire pumps operating at 100 lb. pressure and delivering 500 to 700 gpm., the manufacturer states.



Climax R4U Standby Fire Pump

Climax Model R6U engine is approved for 1,000 gpm. pumps.

Climax Underwriters engines are furnished complete with electric starter, generator and battery, instrument board, including all necessary instruments mounted on engine, water-cooled manifold, stub shaft, vacuum fuel pump and vacuum tank and with or without mounting frame or bed plate, making a complete unit ready to assemble with the pump without additional special mounting and installation engineering.

Blue prints and instructions are furnished with each engine.

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Discovering Natural Laws a Specialty

Thousands specialize as teachers of scientific laws where scores specialize in discovering new laws. About the same ratio exists between researchers who merely collect facts and searchers who determine their relationships and significance.

As an illustration of the difference between researchers, consider Nicholson, who discovered the ninth satellite of Jupiter, and Einstein, who found out why Mercury's perihelion revolves about the sun. The one photographed the heavens about Jupiter and found a streak on a plate that showed the existence of a new moon. The other busied himself with no telescopic observations, yet by study of the fundamental physics of motion discovered certain laws that may eventually aid in revolutionizing astronomy. Already Einstein has given to astronomers a formula by which the diameters of stars may be calculated if certain spectroscopic data and mass are securable.

Important as is the work of such men as Nicholson, the observer, far more important is the work of such men as Einstein, the interpreter. While observers are relatively numerous, interpreters always have been, and still are, scarce. Curiously enough, most observers seem to be somewhat jealous of interpreters who undertake to explain what the observed facts mean. At any rate they are prone to ignore or to belittle any new theory that relates to their realm. They act as if they regard the theorist as an amateur who is trying to instruct the professional. This attitude indicates failure to realize that the art of discovering natural laws and the formulating of new theories is itself a specialty. Once that art has been well mastered, its possessor usually is able to make discoveries in many different realms. The professional observer or experimenter in each of these realms often fails to understand how an "outsider" can enter his particular realm, quickly penetrate a mass of data and find a hidden law that binds seemingly disconnected facts into an organized whole. The lack of understanding that such an achievement is possible to men who specialize in theoretical research, perhaps accounts for part of the difficulty that the latter find in securing acceptance of their discoveries by the very men who should be the first to put their stamp of approval upon them.

Illustrative of the attitude of many scientific teachers and observers toward research theorists we may cite Agassiz. When he advanced the theory that a great and prolonged ice age had once existed, and that practically all of northern Europe had been covered with a deep ice cap, a chorus of disapproval arose from teachers of geology, many of whom were good observers. Among them was Prof. Braun, who, having taught Agassiz the little that he knew about geology, was particularly certain that he could learn nothing from this former student. "Stick to your fishes, Louis; stick to your fishes," he cried, for what could be plainer than that only a specialized geological observer could ever hope to discover a new geological principle or law? But Agassiz refused thus to be limited, and steadily continued to pile up evidence in favor of his ice age theory. By instinct he was a theorizer, although his training had made him also a good observer. His greatest delight was in discovering some broad principle, and he found a splendid opportunity for such discovery in the realm of geology. Yet it was not for two generations that practically every geologist in Europe had capitulated to the Agassiz ice-age theory.

For the specialist in the discovery of the causes of effects, science often has no boundary. Having learned how to interrogate Nature successfully in one corner, such a specialist usually finds no difficulty in making her answer his "fourth degree" questioning in the other corners.

More than half a century ago it was recognized by a few discerning scientists that the discovery of natural laws is itself a specialty, as the following quotation shows.

E. L. Youmans, in Popular Science Monthly, November, 1874, on "Spencer and Evolution," said:

"In the scientific world, the accumulation of facts has outstripped the work of valid generalization. For, while men of moderate ability can observe, experiment, and multiply details in special departments, it requires men of breadth to arrange them into groups, to educe principles and arrive at comprehensive laws. The great mass of scientific specialists, confined to their departments, and little trained to the work of generalization are apt to regard lightly the logical process of science, and to decry mere theorizing and speculation. They forget that facts of themselves are not science, and only became so by being placed in true relations, and that the function of the thinker is therefore supreme; while the work of organizing facts and establishing general truths is, after all, just as much a specialty as that of observation or experiment in many branches of inquiry. The prevalence of these narrow views has been unfavorable to the recognition of Mr. Spencer's work by a large class of the cultivators of science; and the more so, as he has been mainly occupied in the highest spheres of generalization. For this reason it is only by the comparatively small number of scientific men, who possess marked philosophic power, that his labors have been justly appreciated."

Need of Further Study of the Boulder Dam Project

The announcement comes from Washington, D. C., that no power company will bid on the electric power to be developed on the Colorado River and that the city of Los Angeles can not obligate herself to the necessary extent without exceeding her debt limit; so the so-called Boulder Dam project seems to have hit a few financial boulders at the very start.

The federal bill that made the government the sponsor for this project requires that sufficient income from the project be assured in advance, to pay not only the operating expenses but to amortize the investment within 50 years. The politicians who "engineered" the bill thought that engineers who questioned the possibility of contracting to sell the power to power companies were "all wet" and perhaps somewhat prejudiced. But the power companies of southern California now refuse to make any sort of bid for power under a contract that binds them for 50 years. They say that already they are generating power by steam at a cost that makes the hydroelectric power unattractive, and that, looking forward to a continued reduction in the cost of steam generation, they dare not enter into any 50-year contract for power. No engineer who has much knowledge as to the cost of generating power by steam would be apt to advise a power company to do anything else than these power companies have done, namely to refuse to sign a 50-year contract for hydro power.

There is one feature about such a contract that has not been discussed by the politicians who sponsored this bill. We refer to the money that will be lost by any purchaser of this power during the period when only part of it can be sold. Let it be assumed that the hydro power plant will be ready for operation 8 years hence. Some one must pay the interest charges on the investment during those 8 years, but we refer not to that big item but to the sequel to it, namely the interest charges on the unused part of the plant after operating begins. Now, under the bill, both these expenses must ultimately be paid by the power companies, cities, etc., that contract to use the plant, for the entire cost of the project must be amortized in 50 years from income received. The interest during construction will probably not be much less than 20 per cent of the cost of the project, and we would not dare advise a power company or city to estimate less than 30 per cent more to cover the "development cost" or sequel to interest during construction, for it is not probable that a full use of the plant would be reached short of 10 years after its completion. A conservative estimate for interest during construction and for subsequent interest on the unused part of the plant would be 50 per cent of its construction cost.

Should it be argued that the growth of southern California would suffice to create a demand for all the power from Boulder Dam during its construction period, the answer is that the power companies would have had to meet that growing demand every year during construction, by enlargments of their existing plants. Hence, when Boulder Dam power becomes available, either the then existing steam plants would have to be scrapped or lie idle; and, in either case, who is going to foot that bill?

As is usual when politicians "engineer" such public projects, the public finds itself in a mess. This project is a problem in engineering and business economics that should never have been made a political issue until it had been completely solved by competent experts. That it had not been completely solved was very plainly stated by the last board of engineers that reported on it. But that report was either brushed aside or misinterpreted by congressmen who were eager to be seen doing something big for their constituents before the next election. They have done something big but not exactly the big something that they thought they were doing.

The editors of "Engineering and Contracting" are of the opinion that the Boulder Dam project should be shelved until at least four entirely separate engineering boards shall have investigated the wisdom of building any such dam on the Colorado River. Where hundreds of millions of dollars are involved, it would not be extravagant to employ every eminent consulting hydraulic and power engineer in America to aid in reporting upon it. Let the "doctors disagree" as much as they may and there will be disagreement enough we may be sure—the first important thing to decide is the economic merit of this project. By securing adequate data, by threshing out the different interpretations of the data by many experts, an important board of engineers appointed by President Hoover can probably reach a correct decision.

It has been urged by the State Engineer of Arizona that Los Angeles can secure an adequate water supply from the Sierra Nevada Mountains. It has been urged by other able engineers that a gravity supply can be secured from the Colorado River by going farther north. It has been calculated that the silting up of the Boulder Dam would so rapidly reduce its storage capacity as to prevent the production of power on a large scale after a few years. It has even been suggested by engineers that a cheaper source of water for southern California is the Sacramento River.

This whole economic problem is by no means a simple one. Indeed, it is so complex that there are grave doubts whether its correct solution has yet been found.

H. P. Gillette

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Greetings to the Dean of U.S. Traveling Meter Salesmen, Geo. H. Carr

Forty-three years of continuous service in the meter business, as a record not of an organization but that of an individual, is a record deserving of comment.

Dean of the U. S. traveling meter salesmen is a title justly earned by long and continuous service in this field by Mr. George H. Carr, for forty-three years in the meter industry, the past twenty-six being with one company, the Worthington Pump and Machinery Corporation.

Geo. H. Carr in Charge of the Meter Department for the Worthington Pump & Machinery Corporation at Chicago

In August, 1886, Mr. Carr entered the employ of the Union Water Meter Company of Worcester, Mass., as a shipping clerk and by 1890 had advanced to that of traveling salesman. In 1898, after twelve years with this company, he severed his connection with them to travel for two years through the south for the National Meter Company. At the end of this time he entered the Chicago office of the Hersey Manufacturing Company.

In September, 1903, he was placed in charge of the central states meter business for the Worthington Pump and Machinery Corporation, where the first of September he will round out twenty-six years in the service of this company and end his forty-three years in the meter industry.

The picture presented with this story is evidence that Mr. Carr is to break this record by many more years. The Chicago office of the Worthington Pump and Machinery Corporation, where Mr. Carr is located, is at 37 West Van Buren St.

O. B. Avery Company of St. Louis to Handle Monarch Tractors

The O. B. Avery Company of St. Louis, distributors of construction equipment, have recently taken on the Allis-Chalmers Monarch Tractor line. This company has become a factor in the construction industry in the St. Louis territory, through their long established policy of cooperation with the contractor in every phase of his work. The addition of the Monarch Tractor to their already complete line of equipment is in keeping with this plan of cooperation.

In commenting on the new arrangement, one of the officials of the company said: "Allis-Chalmers Monarch Tractors are fast becoming known as outstanding tractors in power and performance due to the advanced design and development made since the Allis-Chalmers Manufacturing Company purchased the Monarch Tractors Corporation a year ago. One of the biggest points of the Monarch is its remarkable ability to keep all feet on the ground and pull—no matter how heavy the load, even under the most unfavorable conditions."

The O. B. Avery Company has a service department well equipped for handling repair work quickly and economically, under the direction of skilled tractor mechanics, and the possibility of loss of time to the contractor due to breakdowns, is cut to the minimum by carrying in St. Louis a complete stock of repair parts.

In addition to the Allis-Chalmers Monarch tractors, the Avery Company represent Northwest Engineering Company, Chicago; Chain Belt Company, Milwaukee, Wis.; Sullivan Machinery Company, Chicago; Buckeye Traction Ditcher Company, Findlay, Ohio; Butler Bin Company, Waukesha, Wis.; National Hoisting Engine Company, Harrison, New Jersey; G. H. Williams Company, Erie, Pa., and other well known lines. The St. Louis offices and

Headquarters of O. B. Avery Company, St. Louis, Mo.

warehouse is located at 1325 Macklind Avenue, where the visitor is always welcome if seeking information concerning any of the products handled by this company.

LaBour Increases Distribution Points in New York Territory

Eastern purchasers of LaBour pumps may now place their orders direct with the New York office of The LaBour Company, or with other distributors representing them.

LaBour products have previously been handled in the New York territory exclusively through Mott and McElrath Engineering Corporation. But, with a view to broadening the distribution service the exclusive feature of the arrangement with this company has been discontinued, although they continue to represent The LaBour Company.

In Mexico

The Pennsylvania Pump and Compressor Company of Easton, Pa., makers of vacuum, centrifugal and air lift pumps and compressors have appointed Wells, Fargo & Company, Express, S. A., Apartado Postal, 361, Mexico City, as distributing agents for the Republic of Mexico.

Distributor Note

Yeomans Brothers Company, Chicago, manufacturers of sewage ejectors, pumping machinery and rotary air compressors, announces the appointment of the Capitol Equipment Company, Bank of Commerce Building, Charleston, W. Va., to represent them in the Southwestern part of that state.

Capitol Equipment will handle a complete Yeomans line, which includes sewage ejectors, bilge or sump pumps, water supply pumps, general service pumps, condensation return pumps and rotary air compressors.

Frank T. Fay

Frank T. Fay, sales manager of the Asphalt Department of the Standard Oil Company of New York, Boston Division, died suddenly in his apartment at the Parker House, Boston, Sunday, May 5th.

Mr. Fay was 70 years old. He graduated from the Worcester Polytechnic Institute in 1878, and had been with Socony ever since, making a notable record of fifty years in the service of the company. He was a pioneer in the road oil and asphalt business in New England. He had been in charge of the department which he headed since its beginning.

United Tractor & Equipment Adds to Membership

The total membership of the new United Tractor & Equipment Company of Chicago has now reached forty, according to a recent announcement of its president, Mr. Milton W. Anderson. Mr. Anderson announces as new members of the organization, the Maine Steel Products Company of South Portland, Maine; the I. B. Rowell Company of Waukesha, Wisconsin, and the Northwestern Manufacturing Company of Milwaukee.

Mr. Anderson states that the announcement of the formation of the United Company for the co-operative manufacturing and marketing of a full line of machinery centering about the United Tractor, built by the Allis-Chalmers Manufacturing Company brought many requests for membership and assignment of territory.

The tractor is being sent out in carlot shipments throughout the country, and Mr. Anderson reports wide interest shown by manufacturers, distributors, dealers and customers in this product which is offered, for the 1929 season, with a full line of implements and industrial equipment, by a group of non-competitive manufacturers, to be sold through similarly functioning distributors.

A Distributor Note from Florida

Some of our readers may not know that the old firm of McDonald and Burgman, formerly located at Jacksonville, Fla., is now operating in different sections of the state as two separate companies. These two companies are now known as the McDonald Tractor-Equipment Company of Orlando and the Burgman Tractor-Equipment Company of Jacksonville.

The McDonald Tractor-Equipment Company covers the southern half of the State of Florida and Burgman Tractor-Equipment Company covers the northern half. They continue to represent the same lines as those carried by McDonald & Burgman, which include: "Caterpillar" tractors. Russel graders, Athey wheels, P&H excavating machines, Killefer equipment, Plymouth locomotives and other lines.

Burgman Tractor-Equipment Company continues to occupy the headquarters of the old company at 8 Riverside Viaduct, Jacksonville.

Two Iowa Firms Combine to Make Armco Ingot Iron Culverts

The Independence Corrugated Culvert Company of Mason City and the Iowa Pure Iron Company of Des Moines are now installing machinery and equipment for the manufacture of Armco Ingot Iron corrugated culverts and accessories at Cedar Rapids, Iowa. The plant will be operated jointly by the two companies.

It is announced that the addition of the Cedar Rapids plant, together with the plants at Des Moines and Mason City, will enable them to give prompt and efficient service to all Iowa points. The address of the Cedar Rapids plant is Box 67.

Flox Company of Minneapolis Takes On New Line of Water Level Control Equipment

Mr. C. S. Childs, general manager of The Flox Company, 430 Oak Grove, Minneapolis, Minnesota reports that they have recently taken on a new line of water level control for elevated tanks. It employs the barometric principle through use of a mercury column, exerting the pressure from the mains through needle valves, which irons out the surges and line pulsations and, accordingly, raises and lowers the mercury level, so that water levels can be maintained within a 1 foot range, if necessary.

The Flox Company have been distributors and service engineers for several years for the National Aluminate Corporation and the International Filter Company, both of Chicago.

Highway Trailer Is Going Strong in Cincinnati

A report published in the City Bulletin of the City of Cincinnati states that Highway Trailers have tremendously increased the efficiency, lowered the cost and improved the service of the department.

In 1927 the City of Cincinnati ordered eight trailers from the Highway Trailer Company of Edgerton, Wis. In 1928 an order was placed for ten, and so satisfactorily have they been working out, the 1929 order is reported to be for forty-four. The accompanying picture shows a train of trailers at work gathering refuse for the City of Cincinnati.

Train of Highway Trailers, One of Many Now Operating in City of Cincinnati

Central Iron & Steel Company's District Offices Announce Change of Address

Central Iron & Steel Company of Harrisburg, Pa., has recently announced changes in the location of its New York and Pittsburgh offices. The New York office formerly located in the Evening Post Building, is now in the new Cunard Building at 25 Broadway, Suite 516. The address of the Pittsburgh office, which was formerly 1606 Commonwealth Building, is now 1721 Oliver Building.

Central "Knobby" non-skid floor plates identifies the products of this company, which also manufactures steel plates of various kinds for the trade.

Change of Address

American Hoist and Derrick Company announces the removal of their Chicago office from the Fisher Building to 1000 Engineering Building, 205 W. Wacker Drive, and of the Pittsburgh office from 604 Chamber of Commerce Building to 901 Farmers Bank Building.

Municipal News and Water Works

Vol. LXXVI JULY, 1929 No. 7

Night View of Plant Showing It Illuminated with Monticello Search Light. The Secondary Aerators are in the Foreground

Slow Sand Filtration at Charlottesville, Va.

The Development and Results of Operation

By LEE H. WILLIAMSON
Consulting Engineer, Charlottesville, Va.

AN historical summary of the development of the Charlottesville Water System is essential to complete understanding of the treatment problem as is a description of the physical elements of the system.

Prior to 1925, Charlottesville's water supply was from two impounding reservoirs, located in the "Ragged" mountains about three miles southwest of the town. In elevation the reservoirs are deficient for adequate pressures in the western part of the city and at the University of Virginia.

This supply demonstrated its inadequacy as early as 1918. During the late spring, summer and early fall the water had an intensely disagreeable odor, taste and color, resulting principally from algae. Copper sulphate treatment was resorted to, but with little success.

In 1922 a pumping station was constructed on Maury Creek, a small stream flowing from the drainage area below the reservoirs, pumping back into the reservoirs for storage, a means of augmentation which not only did not improve the stored water but which was expensive due to high heads.

During the summer of 1921 the situation, both as regards inadequacy of the supply and the repellant physical characteristics of the water, became unbearable and the city officials began investigations of additional sources simultaneously with studies of treatment requirements. Surveys were made of all available sources including the Rivanna River, with the result that a gravity supply from Moorman's River was clearly demonstrated as the logical addition to the supply.

On Nov. 11, 1921, George W. Fuller of New York, Dr. M. G. Perrow of Lynchburg, Major R. Messer, Chief Engineer of the Virginia Board of Health, and myself reported unanimously in favor of a slow sand filter with preaeration, located on the Observatory Mountain, as sufficient and most economical treatment of both existing and proposed supplies. Construction was immediately begun and operation commenced in the Fall of 1922.

In 1922 and 1923, there were again acute shortages which were temporarily relieved by the installation of modern pumping equipment at Maury's Creek, so connected as to pump direct to the

new filter plant. Early in 1924 the development of the Moorman's River source was begun and the water turned into the mains on March 30, 1925.

The Completed System.—The completed system at Charlottesville, therefore, may be briefly described as follows:

The intake, consisting of simply a diversion weir, is situated in Jarman's Gap developing a total drainage area of approximately 23 sq. mi. of rough, mountainous, heavily forested land. Just below the intake is situated the grit chamber and from this an 18 in. cast iron conduit leads to the storage reservoirs near the city. This conduit is designed for pressure on the hydraulic gradient so that the only cut off is at the intake. Topography, however, allows short lengths to be drained in case of emergency repairs. The 18 in. line connects into the old 18 in. and 10 in. mains from the storage reservoirs to the filter plant, so cross connected that water may be drawn from either the reservoirs or direct from Moorman's River through either the 18 in. or 10 in. main.

With this system of connection it was necessary to prevent static pressure on the pipe line by closing valves at the filter plant or at the cross connection. Moreover, the Moorman's River conduit has a far greater capacity than present requirements and it as desired to store Moorman's River water in the reservoirs whenever possible. An open control chamber was, therefore, constructed on the hydraulic gradient so that in case of a shut down below this point all water flowed to storage in the reservoirs through the control chamber or under normal conditions the excess supply from Moorman's River, over the demand at the filter plant, flows through the control chamber to storage.

A booster station for use when drawing from the reservoirs is located near the filter plant with suitable connections to allow combined use of Moorman's River water by gravity and boosted water from the reservoir. Eighteen, 10 and 6 in. mains lead from the clear-water reservoir to the distributing system in the city.

Basic Elements in Selecting Treatment Plant.—The 1921 survey of purification requirements discovered the following elements as basic in selecting the location, type size and extent of treatment plant.

1. Two sites were available, (a) at the Impounding reservoirs and (b) on the Observatory Mountain near the University.

2. The location in elevation should be such that delivery by gravity to all parts of the city then developed or or likely to be developed in the future could be accomplished. This required the correction of notable pressure deficiencies in the western part of the city and at the university. The location was further qualified by the requirement that a supply from Moorman's River could be economically brought in by gravity, without seriously curtailing its drainage area.

3. The situation demanded a location lending its self to economical and speedy construction, with due regard for facility of operation.

1. Treatment of the existing supply required:

(a) Removal of some pollution though the water shed was municipally owned.

(b) The removal of color, taste and odor of a marked degree.

(c) The reduction of iron.

(d) The removal of very slight turbidity.

2. Treatment of the proposed new supply from Moorman's required:

(a) Removal of possible pollution. No part of the shed being owned by the city, the drainage area being 25 sq. mi., impossible of acquisition and difficult to patrol if acquired.

(b) The removal of fairly large suspended matter during the periods of flood flows.

(c) The reduction of iron.

Water from both supplies was very soft, moderately high in iron and it was evident that large volumes of fresh, clear water from Moorman's River added to the impounded supply, would vitalize the latter and greatly improve its quality.

Capacity.—1. A Pitometer survey in 1920 showed the average daily consumption as approximately 1 Mg. with the per capita consumption about normal.

2. Provision for a service supply, situated by physical necessity well away from the points of demand and the desirability of a uniform rate of filter operation dictated a large clear water reservoir. Peak rates were then secondary in the determination of the total plant capacity though they further influenced selection of a large clear well capacity as an investment economy over increased plant capacity.

Consideration of these principal, and numerous other secondary, elements, together with careful study as to the ultimate economy to be gained, led to unanimous recommendation of the slow sand type of filter with aeration, with the following thoughts uppermost as regards location, type and size.

The location at the old reservoirs was very inaccessible, served by no improved roads, and requiring a 5-mile haul for construction materials. Conversely, the observatory location was close, easily accessible, and provided many advantages and economies, both of construction and operation.

The turbidity to be removed was well within the proven ability of slow sand filters without coagulation or pre-treatment. The taste and odor being principally due to various forms of algae, were capable of adequate treatment by aeration, as was reasonable reduction of iron. The color, though high, was not beyond the capacity of the slow sand type, whose high bacterial efficiency has been undeniably demonstrated.

Simplicity of operation and consequent lower labor costs, the elimination of chemicals, lower wash water requirements, and the small size of the plant presented marked economies, in this particular case, even in the face of greater investment per unit of capacity for the slow sand filters over that for mechanical. In short, the situation was ideal for the slow sand filter with no single feature demanding mechanical filter treatment. Selection of the slow sand filter, in this instance, is as obviously correct as is the selection of the mechanical filters for the city of Richmond, for instance.

With an average demand of 1 Mgd. and clear well capacity of 1 Mg., this capacity being selected primarily in

General View of Plant, Showing Secondary Aerators in Foreground

Primary Aerators at Rear of Plant

deference to its distance from the point of demand, the desirability of a uniform operating rate and economy of Filter Construction, it seemed amply sufficient to provide 2 Mg. of Filter capacity.

Basic Data for Design.—Accordingly, the design was developed from the following basic data:

Capacity 2 Mgd.

Rate: 5 Mg. per acre per day.

115 gal. per sq. ft. per day.

08 gal. per sq. ft. per minute.

This determined the total area as .4 of an acre which was divided into 4 beds of .1 acre each.

Gravel was 12 in. deep as below.

7 in. retained by 1 in. mesh, none over 2 in.

2½ in. passing 1 in. mesh retained by ⅜ in. mesh.

2½ in. passing ⅜ in. mesh with effective size of 2 to 3 MM.

Sand was 36 in. deep as follows:

Maximum turbidity 200 p.p.m. Silica sbd.

Effection size .36 MM.

Uniformity coefficient 2.00.

The under drains were 12 in. split tile with joints laid ¾ in. open.

The area drained by each line of tile was 1,089 sq. ft. as against 1,200 sq. ft. maximum area for efficient velocity.

Friction in drainage system .09 ft.

All piping was amply large with the express purpose of conserving friction resulting in the following velocities:

Under drains, .55 ft. per sec.

Main Collector Lines, .90 ft. per sec.

Effluent Lines, .99 ft. per sec.

Troubles Operating and Their Correction.—During the first few weeks of operation the effluent had a milky color due probably, to silacious material in the sand bed. This cleared nicely, however, and at about the same time the bacterial efficiency began to pick up.

During the first summer the water from the reservoirs was at its worst due to drought and stagnation. The beds clogged rapidly and for several weeks had to be cleaned once a week. Then a red slime appeared in the clear water reservoir, having the appearance of red mud, in which small red worms bred. Experiments were at once started to determine the cause and it was found that the water was abnormally high in iron in the ferrous state which thus passed the filters in solution, was oxidized by aeration and precipitated as ferric iron in the clear well.

The remedy was the installation of aerators ahead of the filters with sufficient detention for the floc to form. The installation of this equipment relieved the clogging of the filters so that a minimum period of two weeks was maintained between scrapings when bad weather prevailed.

Enlargement.—After this correction, the effluent was excellent and in spite of the rapid installation of meters the consumption increased perceptibly. Moreover, certain industries who had previously maintained private supplies asked to be supplied from the municipal system. Since their demands totalled several hundred thousand gallons daily it became necessary to study means of increasing the filter capacity.

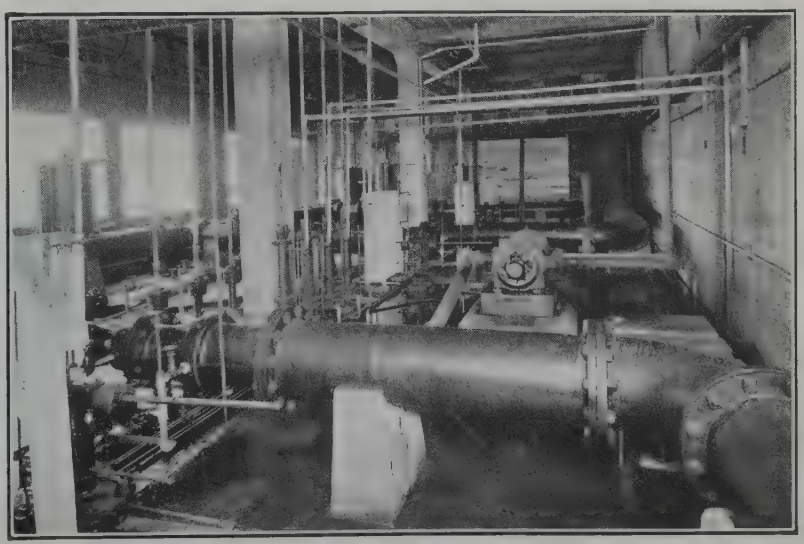
Studies were made on the basis of additional 3 Mgd. per acre rate filters with estimates of cost and found to be beyond the then financial ability of the city.

In studying the troubles encountered during early operation, an experimental filter was constructed and the results obtained indicated the possibility of using a higher rate of filtration, especially since the Moorman's River supply was assured and improvement of the raw water, even during the summer months was confidently expected. With completion of the new supply, better water was an accomplished fact, therefore the city council subsidized a series of experiments during the summer of 1925. These covered operation of a small experimental plant at various rates with studies of the water during all stages of the processes, together with studies of the water in its passage through the slow sand plant.

These experiments were made under conditions which were as adverse as can be expected, that is, when most of the water was being furnished from the storage reservoirs during an exceedingly dry season and before the Moorman's River supply had time to reach its maximum effectiveness in the improvement of the impounded supply.

The results may be summarized briefly as follows:

This water had no characteristics which would preclude an increase of rate to 10 Mg. per acre per day. Both color and turbidity ranged between 20 and 27 parts per million. In was found, however, that the water was very high



Controller Room and Pipe Gallery

in iron and the importance of preliminary aeration was clearly demonstrated. That is, it was necessary to remove as much of the iron carried in solution as possible, as otherwise it so passed the filters and was precipitated by the secondary aeration. Since preliminary aeration causes the formation of a floc the question of providing settling basins ahead of the filters was studied carefully with the idea that the load on the filters might be materially reduced by allowing the floc formed to precipitate out before the water was applied to the filters. It was found, however, that due to the nature of the floc, a period of about 15 minutes was all that was justified, since over a six hour period, only 17 per cent settled out and 65 per cent of this was settled out during the first 15 minutes.

Operating Gallery and Nichols Sand Washing Machine

The experimental filter was rigged with a pre-aerator and 15 minutes sedimentation ahead of the filter, with a secondary aerator after filtration. Operating at a 10 million gallon rate the effluent was excellent, the following tabulation showing the condition of the water at various stages of the process:

	Raw Water	First Aeration	After Filtration	Secondary Aeration
Temperature OC	23.5	23.5	23.5	23.5
Turbidity	27.0	25	5.0	5.0
Taste	Faint, Earthy	Faint, Earthy	0	0
Color (apparent)	21	20	3	3
Alkalinity	0	0	0	0
Hydroxide (OH)				
Carbonate (CO_3)	0	0	0	0
Bicarbonate (HCO_3)	18.5	17.9	18.1	17.5
(In terms of $CaCO_3$)				
Iron	0.76	0.70	.04	.04
Free Carbon Dioxide	9.30	3.7	6.1	1.6
Dissolved Oxygen	1.54	6.01	2.04	8.07
Per Cent of Saturation	17.9	69.8	23.7	93.8

Practically rates as high as 10 Mg. per day had been used only in an experimental way in this country, the most noteworthy experiment having been carried out at the Washington filter plant during 1908 to 1910, inclusive, covering a period of approximately 1½ years. These experiments were made with Potomac River water at best infinitely more turbid than the Charlottesville supply at its worst. They demonstrated that up to a rate of 10 Mg. the loss in bacterial efficiency was very small and that the cost of filtration was approximately 33 per cent lower than with a rate of 5 Mg.; also experiments at the Lawrence filters showed practically the same results, that is, that bacterial efficiency was very slightly decreased between rates of 5 and 10 Mg. per acre.

Both experiments, however, demonstrated the importance of the cleaning method used, as uniformly better results were obtained when the filters were cleaned by scraping, as is the usual method for cleaning this type of bed, than was the case when they were cleaned by the reverse flow method.

As a result, one filter was revamped to operate at the new rate of 10 Mg. per acre per day by increasing the aerator capacity ahead of the filter and providing 15 minutes sedimentation; reconstructing the drainage system by installing two 10-in. by 12-in main collectors and 6-in. split tile laterals; and installing new controller equipment of increased capacity. Thus a filter which previously had 5 Mgd. capacity new has been doubled.

The results obtained were in every respect excellent and the period between scrapings was not perceptibly shortened. The three other beds were, therefore, similarly revamped at a total cost, including the absorption of the experimental cost of $16,936.84 or $8,468.42 per Mg. of increased capacity. These figures also included the replacement of some sand and gravel lost during the change. Also the new sand was carefully selected and carefully mixed with the old sand so as to reduce the effective size to .34 mm. and to somewhat improve the uniformity coefficient. The mixing was accomplished by repeated washings with the Nichols machine.

The cost of $8,468 per 1,000,000 gal. of increase may be compared with $51,000, the estimated cost per 1,000,000 gal. of capacity of additional filters operating on a 5,000,000 gal. per acre rate.

No major troubles, either of operation or sufficiency of treatment, have been encountered since the revamped plant was put into operation in the summer of 1926 but, as will be later shown, the cost of operation has been steadily lowered. The average time between scrapings for 2½ years' operation on the 10 Mg. rate approximates 50 days, or only 10 per cent less than the period obtained when the lower rate was used. The sanitary and physical characteristics of the water have equaled in every respect the effluent obtained with the 5 Mg. per acre rate.

During summer months when the iron precipitate was heavy it was found that the installation of a coke screen over the outlet from the preliminary aeration basins relieved the filters of considerable load. These were so arranged as to be readily cleaned and cost only a few dollars each.

Cost of Operation.—In determining the cost of operation only the actual cost of treatment and purification functions are included. Similarly the fixed charges represent only actual investment in treatment and purification works. This method of cost determination is based on the theory that booster pumping and service water storage should have been provided whether or not treatment was necessary.

Thusly, the average yearly cost of water treatment, exclusive of fixed charges, has been as shown in Table I.

The high costs of 1922 and to 1924 are caused by treatment of Maury's Creek water in part and to the generally poor condition of the impounded water during the period immediately preceding completion of the Moorman's River supply. The principal element of cost being labor for scraping and washing during the summer and early fall months.

The plant has been in operation since November, 1922, and this time is log-

Table I

	'22-'23	'23-'24	'24-'25	'25-'26	'26-'27	'27-'28	'28-'29*
Aver. cost of treatment per 1,000,000 gal.	$14.28	$16.78	$7.23	$7.42	$7.90	$5.95	$5.99

*Seven months only.

ically divided into three periods: First, November, 1922 to April, 1925, during which all water came from the impounding reservoirs and Maury's Creek. This water represents the most adverse conditions and covers the starting up and shake down period. The average cost for the period was $8.94 per Mg. Rate of filtration was 5 Mg. per acre per day. Second, April, 1925, to June, 1926, during which Moorman's River water was available, causing a constant improvement of the raw water operation at the 5 Mg. per acre rate, during which water was as under the second phase, but the rate of filtration was 10 Mg. per acre per day, average cost $6.65, or 10 per cent lower than under the same conditions with a 5 Mg. rate.

The average cost over the entire period of operation is $8.94 per Mg. Over the period covering the 5 Mg. rate $11.68 per Mg. and over the 10 Mg. rate period $6.61 per Mg.

These costs include all labor, supplies, maintenance and repairs, together with light and power for washing sand.

The fixed charges over the entire period of operation average $13.53 per 1,000,000 gal., and include a sinking fund for retirement of the outstanding bonds, making a total cost at present of $20.18 per Mg. or .02018 ct. per 1,000 gal.

Acknowledgment.—The foregoing is a paper presented at the First Virginia Conference on Water Purification and Sewage Treatment, held April 25 and 26 at Richmond, Va.

Laying a Reinforced Concrete Outfall Sewer

Steps in the laying of the new San Rafael, Calif., outfall sewer are shown in the accompanying photographs. Sewage is pumped through this line from San Rafael to an outlet in San Francisco Bay. The sewer is built of centrifugally-spun reinforced-concrete pipe of 21-in. internal diameter. Pressures in the line are relatively high, sections of the pipe being reinforced to withstand a 100-ft. head. The design was based upon the estimated population in 1948.

At the End of the Pipe in Place. The Horse Moves Along on Rollers to Handle the Next Section

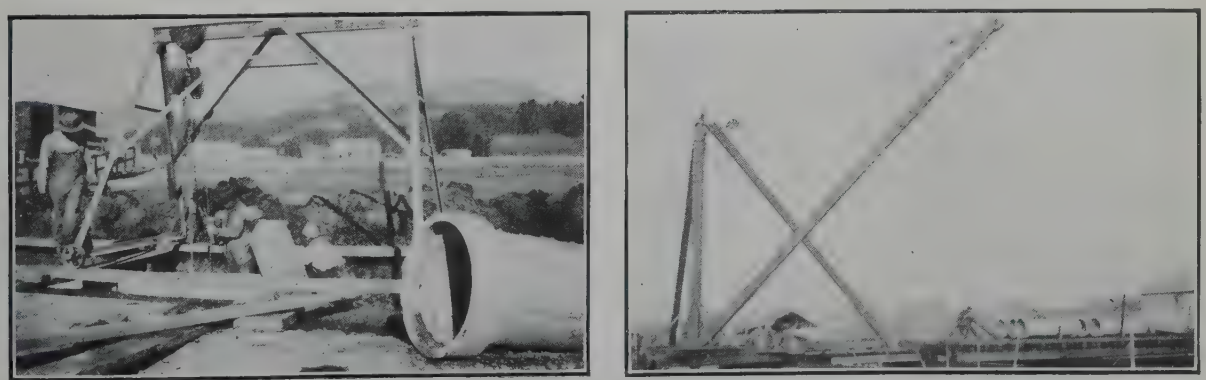
The pipe, which was supplied by the Bent Concrete Pipe Co., was transported from the Oakland plant of that company to San Rafael on barges. At San Rafael it was loaded on trucks and carried to various points along the line where it was unloaded. One of the illustrations shows a derrick unloading pipe from a barge to the pier. A chain hoist, suspended from a heavy steel horse, was used to lower the sections of pipe into the trench. Planks were placed across the trench beneath the hoist, and the sections were rolled over the trench. They were then picked up by the hoist and the planks were removed, allowing the pipe to be lowered into the trench. Redwood cradles were installed in the bottom of the trench to carry the pipe. The horse is provided with small wheels so that it may be moved along the trench on planks laid at the sides. For a wider trench, the wheels may be changed and the horse turned the other way.

City's Powers Defined

Authority of a city to delegate administrative powers and authority for the enforcement of health regulations was sustained in a recent decision of the Ohio Supreme Court in the case of the State ex rel. George Moock, et al, vs. the City of Cincinnati, et al, on appeal from the Court of Appeals of Hamilton County, according to Ohio Health News of June 1. This was a case growing out of denial of a permit to Moock to collect garbage after a contract had been entered into with another contractor for garbage collection and disposal. The opinion was by Judge Jones. The syllabus follows:

The city of Cincinnati advertised for and received bids and entered into a contract with a single contractor who for a consideration paid by the city, engaged to collect and remove garbage therefrom in accordance with the city's specifications. A permit was thereupon issued to the city's contractor but denied to the relator who had contracts for garbage removal with various hospitals and restaurants in the city. This garbage, consisting of animal, vegetable and other products, had a commercial value, much of which being adaptable for the feeding of swine.

Held: Neither the city ordinance nor the refusal of the city manager to issue relator a permit for the collection and removal of garbage contravened any provision of the state or federal constitution.



Left—Lowering a Section of Pipe. The Planks Have Been Removed and the Pipe Is on Its Way Down. Right—The Sections of Pipe Were Carried from Oakland to San Rafael on Barges

The Cobble Mountain Dam of Springfield, Massachusetts

Design Features of a $6,143,000 Development

By ALLEN HAZEN
Hazen, Everett & Pirnie, Civil Engineers, New York City

THE Cobble Mountain Dam is being built by the city of Springfield, Mass., as part of a development of its water supply; E. E. Lochridge as chief engineer is in charge of the entire work. H. H. Hatch is resident engineer for the construction of the dam and tunnels. Hazen & Whipple (now Hazen, Everett & Pirnie) the writer's firm has prepared the plans and has acted as consulting engineer, checking the general plans and estimates, and George A. Orrok has aided in connection with the water power and electrical development.

There have been four principal contracts:

(1) The Diversion Tunnel, let in July, 1927, to Coleman Bros., of Boston, and completed about a year later.
(2) The Main Dam, Spillway and Reservoir was let to Winston & Company of Kingston, N. Y., in July, 1928, and
(3) The Cobble Mountain Tunnel to Frazier-Davis Construction Co., of St. Louis, at the same time.
(4) The surge tank, penstock, power house, and electrical equipment to Turner Falls Power and Electric Co.

Some road and other work has been carried out by force account. The buildings over the shafts and some small parts of the work are not yet under contract. It is the intention that the whole works shall be completed by Oct. 1, 1930.

The Cobble Mountain Dam is larger and will cost more than could have been built at this time from water funds at present water rates and with a balanced budget. It is the auxiliary power that makes it financially possible now. The reservoir is very high in elevation and there was an opportunity (recognized when this source was first proposed in 1905) of developing water power when full storage became available.

After extended study in the last years, a contract was entered into with the Turners Falls Electric & Power Co., under which the company joined with the city in carrying out the development and will pay an annual rental for 30 years for the privilege of generating power.

Hydraulic Fill Type Dam.—The dam is of the hydraulic fill type, with a top width of 50 ft. a freeboard of 20 ft. above spillway level, and 13 ft. above the top of the proposed 7 ft. flashboards. The slopes are moderate and become flatter toward the bottom of the dam.

Rock fill will be a feature of the dam, a large block of this material being placed in each of the toes, rising to a total height of about 110 ft. above stream bed. Part of this rockfill was required by the original design, but after the contract was let the amount was increased by arrangement with the contractor as permitted by the specifications under the unit prices of the contract.

As a finish to the downstream toe there will be a concrete arch with a radius of 100 ft. cut securely into solid rock on each side, and resting without being cut into the rock on the bottom, with spaces for drainage underneath. This arch is 35 ft. high and from 14 to 20 ft. thick and cuts off what would otherwise have been an extreme extension of the downstream toe.

The shape of the dam is unusual. The gorge is narrow and curved. The side slopes are approximately 37° or one on 1.33. The bottom width is something like 70 ft. Under these conditions the dam has a length along its crest of only 700 ft., but is 1,505 ft. wide on the bottom measured along the thread of the stream. It is therefore more than twice as wide as long.

The height of the dam measured from the stream bed to the spillway level is 215 ft. with 7 ft. additional to the top of the proposed flashboards. To the roadway level on the top of the dam it is 235 ft. The cutoff trench in rock will extend 10 ft. or more below stream bed and is not included in these heights.

At the proposed flashboard level, elevation 952, the Cobble Mountain reservoir will have an area of 1,120 acres and will contain 22,287 million gallons of water. Of this amount 2,021 million gallons below elevation 840 are not available for power but may be drawn in case of need for water supply.

In addition to the storage in the Cobble Mountain Reservoir the Borden Brook Reservoir, constructed in the year 1909, on a tributary stream, has a capacity 2,500 million gal. Of this, under the arrangement with the Power Company, 1,500 million gal. may be drawn for power and 1,000 million gal. are held as an emergency reserve for water supply.

The volume of Cobble Mountain Dam is approximately 1,800,000 cu. yd. of which something like 400,000 cu. yd. will be rock fill and the remainder earth. All but a small part of the latter will be placed hydraulically.

Because the stream was not straight, the lower parts of the toes are turned on a regularly graduated arrangement so that the contours of the finished dam, in a general way, will be perpendicular to the sides of the valley. The total curvature of the valley is some 90° from one toe to the other and of the dam 60°, leaving 30° at a sharp bend in the stream near the upper toe. The stream bends to the left and this procedure leads to steeper slopes on the faces of the dam along the left bank of the stream and flatter slopes near the right bank.

The procedure in general was to make the desired standard slope, selected in advance, apply approximately on the side where the slope was steepest and to leave a flatter slope, or, in one case, a berm near the right bank of the stream.

The material in the damsite is mica schist rock covered to an average depth of about 4 ft., with soil.

Cut Off Trench.—To prevent seepage through seams in the rock where the core of the dam is to join the rock, a cutoff trench will be cut across the bottom and sides of the valley to a depth to be determined as the work proceeds. In the bottom of this trench will be dug narrower trenches in which concrete walls will be built extending 3 ft. above the bottom of the sider trench. One of the walls will be carried to the top on each side of the valley.

The rock below the bottom of the trench is to be drilled and grouted to cut off seams and make the rock watertight. The clay core will fill the rock trench and cover the concrete cutoff walls and make a watertight seal.

Material for Rock Fill.—The material for the rock fill is obtained from the mica schist in the immediate neighborhood of the dam. The rock rises on each side of the damsite to about 470 ft. above the stream bed or 230 ft. above the top of the dam, affording opportunities for convenient and ample quarries on both sides. The rock excavated in the course of the work, including that from the spillway, is placed in the dam as rock fill.

The mica schist, although suitable

for rock fill, will not crush to make concrete stock and there is no rock in the neighborhood of the work fit for masonry of any class. Williamsburgh granite found in some of the neighboring hills is not suitable for quarrying. There are quarries of excellent granite within 20 miles of the site but the use of this material for masonry was not seriously considered. All material for both the concrete work and the hydraulic fill must be brought from pits about a mile away.

At the dam site that soil will be sluiced into the dam and there are some limited deposits of fine grained material not far away that may be useful in construction.

The Hydraulic Fill.—The borrow pits for the hydraulic fill are glacial deposits of sand and gravel. There are fine grained layers running down, in places, to rock flour. The deposits are extensive and contain many times the required volume of material. Selection will be necessary to secure the required grain sizes. Pits carrying different grades of material will probably require to be operated simultaneously.

The contractor proposes to excavate the material in the pits with steam shovels and to carry it on standard gauge railway track to the dam where it will be dumped from tracks on the top of the rock fills, or from trestles above them, to the toes of the dam. The material will then be sluiced into the dam.

Water for sluicing is to be provided by floating pumps on the pool in the center so that the water used for building the dam will be circulated and kept separate from the water of the running stream, so as to avoid pollution of the water supply.

As the material from which the dam is to be built is sandy and gravelly in character, the problem of control of grain size is quite different from that in several other hydraulic dams recently constructed in which the percentage of clay has been high.

The specifications provide that the material in the central core shall have an effective size of about 0.01 mm., the intention being to secure a material fine enough to be, for practical purposes, watertight, but, on the other hand, coarse enough and pervious enough to permit the core material to drain sufficiently for its own consolidation.

It will be remembered that in some hydraulic dams built in the past (Hydraulic Fill Dams. Am. Soc. C. E., Vol. 83, p. 1713, 1920) the core material has been so fine that it was incapable of drainage within any reasonable length of time! and has remained permanently fluid in the center of the dam. In some cases the pressure of this fluid core has exceeded the resistance of the toes and has ruptured them during construction.

An absolute requirement of stability is therefore that the material should be sufficiently coarse grained as to drain and become solid and stable.

On the other hand, some hydraulic fill rams of sandy material have been so coarse grained and free from fine material that there has been an appreciable amount of leakage through them.

In the case of Cobble Mountain Dam approximate watertightness is desirable and necessary; to this end the core size must be regulated to insure that the completed work will be nearly watertight with only so much seepage as is necessary to insure drainage and stability.

In connection with this important subject a method of elutriation and microscopical examination has been devised to determine the character of the material being placed in the core as the work proceeds.

Diversion Tunnel.—Before beginning construction of the dam itself, it was necessary to divert the water of Little River. Work on a diversion tunnel 1,620 ft. long was started a year in advance. This tunnel is horse-shoe shaped equal to a circle 12 ft. in diameter and has a slope of 18 per 1,000. Its invert is a few feet above ordinary water level at both ends.

In connection with this tunnel there was built a cofferdam of rock fill, as a preliminary operation, so placed that it would form part of the permanent upstream toe of the dam. This was faced with enough soil to secure approximate watertightness. This cofferdam had a height of 70 ft. and was required to hold the water at a level that would produce a velocity in the tunnel to develop its capacity.

The tunnel was designed to have a capacity of 4,000 cu. ft. per second, and amount comfortable in excess of any flood that had been recorded during the 20 years that the stream had been gauged. On Nov. 3, 1927, four months after the contract had been let, there was a great flood. This was at the time of the Vermont flood. The maximum rate of discharge at the intake dam three miles below was 6,100 cu. ft. per second; and the average for 24 hours almost reached 4,000 cu. ft. per second. This was before the diversion of the stream.

The mean flow at the intake dam is about 62 mgd. It will be proportionately less at Cobble Mountain Dam or about 58 mgd.

The diversion tunnel was lined with concrete and the space back of the concrete grouted. At a convenient place a shaft 218 ft. deep was cut from the surface and a place selected upstream from it for the permanent closure and control works. In this place, after the dam is built, a concrete plug will be placed and grouted. Through this two 42 in. pipes will pass, leading to gates and guard gates in duplicate with discharging capacity of more than 1,000 cu. ft. per second, from which water may be drawn for water supply purposes or to lower the water in the dam in any emergency. Otherwise these gates will not be used.

The capacity of the outlets is such that using both tunnels water can be lowered about 3 ft. per 24 hours, the rate of drop increasing as the water falls. The reservoir could be emptied in about 30 days.

The Outlet Tunnel.—The Cobble Mountain tunnel which will be the ordinary outlet and will supply water to the power house, is 7,100 ft. long and is equivalent in area and capacity to a circle 10 ft. in diameter. It is to be concrete lined throughout and grouted. The entrance to this tunnel is 76 ft. in elevation above that of the diversion tunnel. The sill at its entrance is at elevation 830,122 ft below the top of the proposed flashboards.

This tunnel is driven through mica schist rock, similar in character to that penetrated by the diversion tunnel, and, for the most part, completely dry. A small amount of Williamsburg granite, a coarse grained local variety, was encountered. The tunnel location was selected to give ample rock cover to resist pressure, except in the lower 500 ft. which are to be steel line.

The control of water through this tunnel will be, ordinarily, by gates at the power house and otherwise by a gate at the inlet which can be used to hold the water back while the tunnel and penstocks are unwatered for inspection or repair. This gate is a Broome gate 12 ft. wide and 13 ft. high covering a carefully formed bellmouth.

A short section of tunnel upstream from this entrance is so arranged that when the water is drawn down to elevation 900 or lower, it will be possible to sink an emergency gate to cover the outer entrance and to permit the Broome gate and its seat and everything connected with it to be unwatered. The outer gate will not be provided at present, but the seat will be built so that this remedy may be applied at a future time if it should prove necessary.

Power Development.—At the lower end of the tunnel a steel pipe lining will be used extending to a point where the rock above is approximately at the elevation of high water in the reservoir. At its lower end this pipe is connected to a surge tank and then to three penstocks. These go down a steep declivity to the power house which is built at the end of the small reservoir formed by the intake dam. From the intake dam water is drawn to the filters as needed and the rest of the flow spills down the stream.

The flow line of the Cobble Mountain Reservoir, at the flashboard level, will be 456 ft. above the present flow line of the intake reservoir. This possible head on the wheels will be reduced by drawdown in Cobble Mountain Reservoir and by friction in the tunnel and penstocks. The working head will vary from about 450 ft. down to about 350 ft, with a possible extreme minimum of 330 ft.

It will probably average in the neighborhood of 400 ft.

The power house is provided with a capacity to use water at a rate equal to ten times the mean flow of the stream. It will thus operate on a 10 per cent load factor. This relatively large development is provided with reference to using this plant to meet peak loads.

Daily power peaks will be met by drawing the water required for water supply during those hours of the day when the power will be most useful and the city has storage to carry through the day from water so drawn.

The city at present uses a little less than 15 mgd. and the mean flow of the stream is 62 mgd. The difference, 47 mgd., may be stored and drawn on any days or hours when it will be most valuable during the whole course of the year. This condition will permit a large part of the power to be drawn when water power stations, operated by the company on other streams, are short of water and to meet emergency and peak loads of any kind.

The Spillway.—The spillway of a dam of this character is most important. When the work was started the largest flood on record measured at the intake dam was 4,410 cu. ft. per second. After the work was started there was a larger flood as noted above, with a maximum of 6,100 cu. ft. per second.

From a study of the records of flow of this particular stream, the indications are that the greatest average flow for 24 hours to be expected once in a hundred years would be 4,850 cu. ft. per second.

In view of the character of the occupation of the valley below the greatest precautions were warranted against overtopping of the dam, and it was decided to lay out a spillway channel with a capacity of 20,000 cu. ft. per second, equal to more than 436 cu. ft. per second per square mile of tributary area. This is equal to five times the record 24-hour average flood of the record period.

There was an excellent natural site for the spillway through a notch in the mica schist rock on the opposite side of Cobble Mountain from the dam.

Using this notch required a considerable amount of rock excavation but the rock obtained could be placed and is being placed in the dam.

The crest of the spillway was laid out 135 ft. long. The channel from it drops 15 and narrows as a bellmouth to a width of 50 ft. and then extends with a grade of 1 per cent for a total distance of about 700 feet from the entrance, at which point the rock falls off abruptly on a slope of approximately 31° to the river bed. The total vertical drop is about 255 ft. The flow will reach the river about 3,000 ft. downstream from the lower toe of the dam.

With a well-rounded crest and a gradual approach, the spillway should carry 20,000 cu. ft. a second with about thirteen ft. head.

The water level in the reservoir would then be at elevation 958, at which level it would still be 7 ft. below the top of the dam.

The spillway channel was calculated so that at each point, with an assumed water level, which would pass 20,000 cu. ft. per second, the water level, plus the velocity head, plus an estimate for friction from the entrance to that point would equal the assumed reservoir level i. e., 958.

The allowance for friction not being capable of being estimated closely, a liberal and perhaps excessive allowance was made for it, amounting to 1 per cent of the total distance from the entrance to each point of calculation. Water velocities in the neighborhood of 20 ft. per second were estimated.

The estimated cost of the Cobble Mountain dam and reservoir and the power house and of all that goes with it, but not including the Borden Brook Reservoir built in 1909 nor the land, most of which has been previously purchased, nor other parts of the water supply system, is $6,143,000.

Contracts have been let covering the major parts of the work and a substantial part of the work has been done. Some things remain to be arranged. There is every indication at present that the work will be completed for a sum materially less than the estimated cost.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Relation of Direct Bact. Coli and Bact. Aerogenes Counts Obtained with Cyanide-Citrate Agar, to Sources of Pollution

By FRED C. TONNEY AND RALPH E. NOBLE

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Recently developed direct plating methods of counting coli-aerogenes organisms have made possible the routine determination of separate Bact. coli and Bact. aerogenes indices in 48 hours by the same process in which the combined Bact. coli-aerogenes index is obtained.

Our experience with such a method, employing cyanide-citrate agar as a different medium, led us to consider the possibility that additional data of primary sanitary significance bearing directly on fecal pollution might be available for practical use, in the individual Bact. coli and individual Bact. aerogenes counts, and also in their numerical relation to each other. It was thought that possibly data derived from separate Bact. coli and Bact. aerogenes determinations might offer a better basis for discriminating sanitary judgment of true fecal pollution than can be arrived at from the combined coli-aerogenes index, which includes a variable number of organisms not strictly of fecal origin.

Confirmation studies of the distinctive type colonies on the medium, designated as "Probable Bact. Coli" and "Probable Bact. Aerogenes," indicated a high degree of agreement between the characteristic appearance of the colonies and the recognized differential tests for these two organisms, viz: the methyl red Vogee-Proskauer reaction, the ferric ammonium citrate and sodium citrate tests and the colony characteristics on eosin-methylene blue plates.

The phase of the investigation here reported was directed toward the primary sources from which these organisms find their way into water supplies. It consisted of a quantitative study of the Bact. coli and Bact. aerogenes content of (1) human and animal feces as the primary source of Bact. coli; (2) soils, decayed vegetation and grains as a primary source of Bact. aerogenes, and (3) sewage as a composite mixture derived from the two primary sources named.

A brief summary of the relationship found is given in Table I.

The data indicate that numerically Bact. coli is the organism primarily characteristic of feces; that Bact. aerogenes, although occurring in feces, is numerically insignificant in the aggregate; that Bact. aerogenes is primarily characteristic of coli and vegetation; that the ratio of Bact. coli to Bact. aerogenes in sewage in the Chicago district points to fecal sources and soil sources as contributing in nearly equal proportions to the total number of coli-aerogenes organisms present.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Table I.—Relationship of Bact. Coli and Bact. Aerogenes Colonies from Fecal and Non-Fecal Sources

Source	Samples	Combined Coli-Aerogenes Average per Gram in Aggregate	Percentage Coli	Percentage Aerogenes	Ratio of Coli to Aerogenes
Feces:					
Human	132	92,800,000	99.63	0.37	270: 1.0
Animal	324	689,000,000	99.42	0.58	145: 1.0
Human and animal	456	517,000,000	99.23	0.77	148: 1.0
Sewage	74	88,700*	41.4	51.6	1: 1.4
Surface water	45	176,000†	10.5	89.5	1: 9.5
Cereals	60	397	5.9	94.1	1: 16.0
Soils	20	1,600	0.44	99.56	1:226.0
Decaying wood	17	7,940	0.22	99.78	1:446.0

*Per cubic centimeter. †Per 100 c. c. ‡Based on aggregate content of each source.

The Importance of Regional Planning

The Need for the Regional Planning Association; Its Problems

By J. R. FAIRMAN
Manager Southeastern Offices, Portland Cement Association

NEARLY everyone has in mind some city improvement he thinks would be of great benefit; one man wants the street on which he lives paved, another wants a park established, still another believes a certain street should be widened, this man would like to install a new system of traffic lights, and so on. With all this disunified thinking and planning, I sometimes am forced to wonder how many communities have achieved any semblance of order.

Almost overnight the automobile has changed our mode of living. Through the ability of the individual to get easily about the country, a new standard of living and of education has developed. A city is no longer self-contained; its prosperity and development depend to a large degree upon the prosperity of an entire region.

Importance of Suburban Communities.—Chief among the several problems confronting the modern city is the provision of adequate facilities for motor traffic. Suburban districts have long existed, but never in all history has their relationship to the city been of such importance and concern as at present. Suburban areas are expanding, cities and their suburbs are now growing together; and the automobile is bringing remote communities nearer to the city. Haphazard growth must be halted, in the face of such tendencies, if a full measure of community efficiency, comfort and beauty is to be attained.

Progressive, populous communities in many parts of the country have adopted regional planning as the medium best adapted to handling this perplexing problem. City planning is not broad enough; our communities are bursting out at the sides. There are greater opportunities in adjacent areas than in the city proper. The picture puzzle of community needs must be solved by trained minds, made available through some such agency as a regional planning commission, whose duties include the analysis of all such factors as population increase, suburban growth, vehicle registration, both present and future, expected industrial development, residential trends, zoning, finances available for improvements and many other items. Equipped with facts, this commission will make recomendations and cooperate with other existing agencies to the end that a regional plan of a comprehensive, forward-looking nature will be carried out.

I had realized, of course, that city populations in Florida were increasing, but I must admit I was somewhat startled to learn that since 1925 the population of Jacksonville has increased by 60 per cent; Tampa, by 85 per cent; Miami, by 128 per cent; and St. Augustine, by 80 per cent.

These growths are phenomenal, yet there is every indication that Florida cities are to continue attracting citizens at a high rate. Your cities still have time to convert themselves into communities that are modern in the fullest meaning of the word.

Unfortunately, regional planning did not exist when most of our cities were created. Without knowledge of the changes to be wrought by the automobile, or of the great size to which cities would grow, the early planners neglected to provide for logical and directed growth. Streets, for instance, were rarely of more than the age old four-rod width. Of all the American cities, with the exception of the nation's capital, the only one I can call to mind that made any early attempt at planning for the future was Detroit.

Experience of Detroit.—That city was destroyed by fire nearly one and a quarter centuries ago, as were so many early communities. Afterwards, a prominent Detroit citizen, Judge Woodward, and Governor Hull of Michigan, were responsible for laying out a new Detroit, a Detroit with thoroughfares of three widths. Streets of minor importance were made 60 ft. wide, secondary radial arteries, 120 ft. and major arteries, 200 ft. This was a marvelous thing, but sadly, later generations, unable to visualize the Detroit of the futre, encroached on these wide rights-of-way and today only a few remnants are in service.

Loss of these broad streets, which would so well have served today's traffic, was a costly thing for Detroit. That city is still paying for it through traffic congestion and through time and money consuming condemnation proceedings and other means to gain back a portion of that space once devoted to streets. All of this could have been avoided through adherence to the original far-seeing plan.

View of Roosevelt Road in Cook County, Illinois

But what Detroit lacks today in extra wide downtown streets, she has made up for in suburban development. A master plan has been adopted that serves as an object lesson for Florida municipalities. This master plan embraces a comprehensive system of wide roads, many of which are already completed, thereby permitting fluidity of present traffic. This plan is a continuing plan; each year definite progress is made toward lengthening the mileage of pavements, none of which is less than 40 ft. wide. In the Detroit region they have a battle cry—"Acquire wider rights-of-way today!" To this might well be added the phrase "for tomorrow they will cost more money."

The master plan predetermines the position of the transportation avenues which form the skeleton of the street system in the outer areas. It provides for superhighways, 204 ft. wide, at three-mile intervals, designed to offer local and through roadways for motor

Waukegan Road in Cook County, Illinois, Widened to 40 Ft.

traffic on each side of a center zone reserved for rapid transit service, or future widening or other development. Intermediate roads 120 ft. wide are located at mile intervals on section lines. A supplementary system of major thoroughfares 120 ft. wide is established at intervals of approximately three-fourths of a mile within the area of present development.

That is indeed an ambitious plan; yet it is already well under way. Words can scarcely convey a true picture of what Detroit and Wayne county have done; I would suggest that if any of you have the opportunity, you spend a week-end in and near the Motor City.

The Regional Planning Association.—Many factors enter into city expansion and development. These are of such a serious nature as to require scientific and thorough study of all the principles involved in order that tax payers may be provided with the facilities and conveniences which are their just due. You will grant, I am sure, that little would be accomplished without some central fact-collecting body to study all the proposals, pushing through to completion those best fitted to the community welfare.

Stated in its simplest form, the purpose of the regional planning association is to make an intensive study of all the factors entering into the community's growth and welfare, so the greatest convenience and comfort may be obtained for the tax dollar. The costly experience of a certain Illinois community must be avoided. There, a splendid 40 ft. pavement was built out into the country, but unfortunately it ended abruptly in a corn field and was of no use whatsoever to the community for a couple of years.

Transportation.—Chief among the problems facing all communities is that of transport. Adequate transport service not only means that railroads and street railways must be well connected, but also that highways and streets shall form a perfect network of main arteries and secondary roads. Street layouts marked by dead-ends, jogs, narrow widths, poor pavement and a total lack of coordination, must be avoided. Industrial traffic must be studied so heavy trucks can be accommodated without hindrance to passenger vehicle traffic. On the other hand, high speed thoroughfares must be constructed so passenger cars will not be unnecessarily delayed by trucks. Through traffic should also be taken care of. The idea that motorists whose destinations are far away should be directed through the downtown section of cities is now old fashioned. By-pass routes must be provided so this traffic can continue on its way unhampered, and what is more important, with no inconvenience to the home community.

Water and Sewage.—Water and sewage must be given careful attention in the makeup of the up-to-date community. The automobile has made it possible for the downtown worker to establish his home in the outer precincts of the city or even out in the country. Sanitation must be carried to him. Villages and suburban centers must cooperate, for in this cooperation the citizen is given better service with complete safety and at lower cost. Without planning, it is too easy for much needed projects to be neglected and to become political footballs. In the Passaic Valley of New Jersey, for example, a trunk sewer now serves a thickly populated region embracing quite a number of separate municipalities. It was proposed to establish this sewer more than twenty years ago, but endless litigation and negotiation was necessary before it became a reality. All this delay was at the public's expense.

Utilities.—Even in the matter of public utilities, the way is open for the city to accomplish a great deal through early planning. Electricity and gas reach out everywhere. Electric lines and conduits through town and country possibly may conflict with the highways. Early planning of highway improvements will give the utility firms an opportunity to develop their facilities for the best interests of the public and also it will aid them in preventing a later conflict for rights-of-way.

Political Obstacles.—One of the greatest achievements open to the regional planning association is the overcoming of problems which I shall call political for want of a better term. The boundaries of governmental units in any region are irregular and often without reason—illogical results of haphazard growth. Areas of municipalities are often either so restricted as to hamper growth, or so extended as to impose some undue burden on the well occupied districts. In the case of the region of

Mona Ave. and Hutchinson River Parkway Grade Separation in Westchester County, New York

Chicago, there are almost exactly 1,000 separate taxing bodies within 50 miles of the downtown section of that city. You are of course not bothered to that degree in Florida. Nevertheless, real progress depends upon the complete cooperation of all governmental units involved.

The Chicago Region.—Here are some of the chief aims of the Chicago Regional Planning Association:

Adequate pavements on every main highway in the region of Chicago, continuous across state, county and city, and their boundary lines.

Adequate paved street connections with the paved highways.

All bridges wide enough for future pavement widening or built so that they may be widened.

Grade separations at all dangerous railway crossings.

Grade separations at the most important highway intersections.

Uniform traffic regulations in every county, city and village region.

Every highway marked only with official, legible signs of cautions and direction.

Every main highway adequately lighted at night.

Trees planted and maintained along every highway for the comfort and delight of all highway users.

Attractive public comfort stations properly located along all important highways.

Chicago, large in itself, is the center of a populous territory and the regional planning problems there are intensified. Nevertheless, the smaller city is faced with the same troubles and identical improvements must come sooner or later.

Planning for a Smaller Community.—Let us look for a moment at the program of a small community—Riverside, Calif., with a population of about 25,000. Riverside has already made remarkable progress and the improvements mapped out for that city bid fair to make it one of the most attractive in the country insofar as appearance, comfort and ease of traffic movement are concerned. Climate is, of course, another matter.

Capitol Drive, 60 Ft. Wide, Milwaukee, Wis.

The steps being taken in Riverside are:

1. Regulation to secure maximum capacity of existing space, including elimination of auto parking, prohibition of obstructive turns at particularly busy intersections, ranking of vehicles, use of most effective signaling, curtailment of unnecessary movements and so forth.

2. Improvement of existing street plan, including elimination of jogs and dead-end traffic streets, creation of distributor and by-pass streets for the business district and improvement of radial and inter-district thoroughfares of the major street plan.

3. Extension of a regional major street plan to cover the whole district for several miles in each direction outside the city limits, and completion of a boulevard and parkway system plan supplementing it.

4. Provision for the readjustment and extension of railroad lines, with gradual elimination of grade-crossings.

Florida Cities.—Regional planning is, of course, quite new and I am much pleased that some of your Florida cities are giving serious consideration to this planning movement. If anything, your problems are more intense than they are in any other part of the country. Florida is growing rapidly, you have a marvelous tourist business, you have an established clientele of winter pleasure seekers. Naturally cities in a state so blessed, will grow faster than the average American city.

Jacksonville, I understand, has a city planner, who is not only confronted with traffic and expansion problems within Jacksonville, but is also obliged to consider the whole of Duval county. Obviously, he must take into consideration the principal arteries of travel into Jacksonville, such as State Road No. 1 from the west and No. 4 from the north and to the south, as well as others.

Travel in that city at present across the St. John's River is over one bridge and by one ferry. Clearly, any comprehensive municipal plan must take into consideration the ever increasing need for additional trans-river transportation facilities. New bridges should be located so as to relieve as much of the intra-city traffic as possible, and provide easy crossing of the St. John's River for through traffic as well as local traffic.

Jacksonville's situation definitely indicates why the modern city must extend its city planning to planning in which the whole region is considered. Tampa presents a problem of similar character. Broad thoroughfares leading into the city must be so located and built as to conform to a plan of the

Four Lane, Hudson River Parkway, Westchester County, New York

greatest possible utility to the city itself.

Miami has already made noteworthy progress through the building of wide arteries. Biscayne Boulevard, 220 ft. wide over an eight-block length, is an excellent example of the type of facility that must be installed if there is ever to be room for the prolific automobile. One of the great difficulties of this modern age is finding a place to park. From this standpoint Biscayne Boulevard is something of a motorists' heaven, for 2,000 cars may be parked along it without hampering travel. You can well imagine what impression Biscayne Boulevard will make on the tourist or home seeker. That latter important individual, particularly will feel, "Here is a city that is progressive, a city that is attempting to make things comfortable for its citizens. I will make my home here."

If your city is smaller than Tampa, Miami and Jacksonville, that does not mean you are freed from the responsibility of regional planning. In fact, it is just as important in the small city as in the large, and frequently more important, for the small community must have something to offer in place of large hotels, office buildings and theatres. Here in St. Augustine there is every indication that before long an improved through route will be needed. Because there is so much of historic interest in this community and so much that must be preserved to the nation for all time, it is highly improbable that the widening of thoroughfares through the old section of the city will be contemplated. However, the ever increasing traffic through the city will shortly demand a broad pavement acting in the nature of a by-pass so the present narrow and winding route may be relieved.

Blue Mound Road, 60 Ft. Wide, Milwaukee County, Wisconsin

Separation of Traffic Arteries.—Superhighways, roads of more than the usual width, elevated street intersections, railroad grade separations, and pedestrian tunnels are a few of the modern facilities forcing themselves into the up-to-date traffic picture. These improvements are no longer regarded with doubt, for cities in many parts of the country have through experimentation proved that they are absolutely practical. One great elevated street separation in Lincoln Park, Chicago, has increased the traffic capacity of Lincoln Park thoroughfares by 300 per cent. That is to say, this one structure has given, in effect, three additional roads. These elevated intersections, wherein one street or road passes over the other, permitting traffic to flow in all four directions continuously and safely, must be placed at strategic points.

The benefits of railroad grade separations are obvious. Surveying accident records, it appears that nothing will eliminate accidents at grade crossings except construction of a bridge over or a tunnel under the tracks so motor and train traffic never will meet.

Need for Wide Thoroughfares.—Wide streets and wide rural roads must be included in every adequate transportation scheme. Thirty years ago the average motor vehicle required a lane only 7 or 8 ft. wide in which to move with ease and safety. Since then the average vehicle width has been increased, the maximum generally being 8 ft. Ordinary speed of travel has doubled or tripled and vehicles have grown tremendously in numbers. Street and highway authorities are agreed that, in metropolitan areas at least, the lane of pavement for moving traffic should 10 ft. wide; for parking parallel to the curb it should be 8 ft.; and for diagonal parking, 18 ft. in width, the latter dimension convertible into an added lane for moving traffic with parallel parking. These lane widths are considered minimum for safety and free movement of traffic under all conditions of light, darkness, rain or dry weather. They are also considered maximum, because a slightly wider lane invites the crowding in of another car, which is dangerous.

The superhighway may roughly be defined as a roadway of ample width for the accommodation of four or more lanes of traffic. Of great importance, is the placement of these

superhighways. They should be so located that the largest number of motorists will be benefited. Superhighways should be built first where they are most needed. Naturally the only way to determine where wide arteries should be built, is by means of a traffic survey. Traffic as it seems and as it actually is, often are two different things. For instance, a traffic count taken at Buffalo, N. Y., revealed figures that surprised even those fairly conversant with that city's traffic problem. More than 50,000,000 vehicle movements across the city line took place in 1927, a daily average movement of over 138,000 vehicles! Other surveys conducted by cities and states throughout the country have in many instances revealed that heavier traffic exists on certain roads than was expected.

Here again there is a definite need for the regional planning association. Varying interests in the community, the ability to pay for additional civic improvements and anticipated future community growth must be considered in location of such thoroughfare.

Acquiring Rights-of-Way.—Another paramount issue is the matter of rights-of-way. The procedure followed by the superhighway commission of Macomb and Wayne and Oakland and Wayne counties, surrounding Detroit, indicates what must be done in all communities expecting to grow. This commission, in anticipation of future highway needs, is acquiring rights-of-way of varying widths up to 200 ft. The width of the original road surfaces has been predetermined. In the future when additional road surface is needed, pavements will be laid without any delay whatsoever.

The regulation of the use of private property by a public agency, through zoning has become well established as a function of government. But what is done by zoning bodies and engineers in the way of placing restriction upon the free use of private property must have a lasting effect upon the community whether the work is well or poorly done—whether the ordinance is well or poorly administered. It is desirable, of course, that the results be the best obtainable.

Through the medium of the regional planning association, and the thorough studies which can be made by such an organization, proper city zoning may be accomplished.

After all, the metropolitan community can be regarded as a child; it must be properly nourished and its development must be properly guided. Clearly, there should be some ruling, guiding hand to correlate the manifold activities of government along this line.

Proper Planning Pays Dividends.—There is no governmental agency authorized or qualified to do the work for a city and its environs too. Whatever is to be accomplished must come through the activities of the citezens themselves. The body necessary to do such work must be non-political, for it must carry on a unified plan through year after year of changing governmental officials. The regional planning associations built up by Chicago, Buffalo, St. Louis and many other cities, have demonstrated the need for such progressive scientific bodies. The modern city is growing more complex. Changes in the organization of the city must come about if it is to keep pace with the changes in our living standards. More is expected of the community than ever before; pure water must always be on hand; streets must be smoothly paved; the schools must be excellent; the parks must be spacious and clean; sewage disposal must be never failing; protection from fire must always be at hand.

All these things cost money, and their costs are personified in the taxes collected by the various governing bodies. If the citizen can be made to realize that the conveniences furnished by his government are in reality part of his personal wealth, that actually through many improvements he receives more than he pays for, he will become more willing to support the improvements which modern conditions require.

All taxpayers are naturally interested in economy; they must be assured that their money is being properly expended. They are demanding that the principles of private business be adopted in conduct of the business of government. The business that is permitted to run itself cannot be as profitable as one that is carefully and thoughtfully directed. Through the medium of a regional planning association the community's growth and future are safeguarded, its funds are most effectively invested in dividend-paying improvements and its energy is most efficiently employed.

Acknowledgment.—The foregoing paper was presented on June 27 before the Florida League of Municipalities at St. Augustine, Fla.

25 Cities Plan Airports

Three New York cities are planning airports or contemplating improvements of existing airports, the Commerce Department announces in making public a list of twenty-five cities in the country where airports are planned. The announcement said that improvements of the Watertown airport are contemplated, while new airports are planned at Middletown and Tupper Lake. Other airports are planned in the following cities:

Eureka, Cal.; Pensacola, Fla.; Brunswick and Montezuma, Ga.; Corbin and Hopkinsville, Ky.; Natchitoches, La.; Calais and Camden, Me.; Winchenden, Mass.; Lake Odessa, Mich.; Benson, Minn.; Pinewald, N. J.; Ephraim, Wis.; Bismarck and Finley, N. D.; Cambridge and Highland, Ohio; Redmond, Ore.; Providence, R. I.; Texon, Texas and Culpeper, Va.

Municipal Yacht Harbors

A survey completed recently by Richard R. Blythe of New York as representative of the National Association of Engine and Boat Manufacturers, shows that a public yacht basin has been a profitable investment for cities. The survey included personal investigations in eleven cities from Boston to Corpus Christi, Tex., as well as reports from a number of other cities.

Miami, which netted $12,435 in nine months out of total income of $14,181, is planning to increase its municipal yacht facilities by 200 per cent.

Detroit, one of the first cities to establish motor-boat wells, netted $9,831 in 1927, but its wells were burned last year and are being replaced with steel and concrete structures to house 288 boats. The city expects an annual profit of $30,000 out of a $250,000 investment. Charges range from $75 to $125 a year, depending on the size of the boat.

Chicago, which has done a great deal for boat owners with anchorages in Lincoln and Jackson parks, is planning to do considerably more, building breakwaters and forming canals as part of its lake front development program. A 42-ft. cruiser pays $30 a year for dockage there; a 60-ft. pays $50.

New York has more pleasure boats and fewer facilities than any waterfront city in the country. The only public accommodations are on the Jersey side of the Hudson, in Palisades Interstate Park. Much conversation is being expended in an effort to get something done for the boat owners there.

Boston is in the same fix as to public facilities, although many private clubs have accessible anchorages.

Down in Houston, Tex., a man bought a speed boat for his sons, discovered there were no adequate facilities, bought a piece of property and developed it, and provided stalls for thirty-five boats. His land cost $20,000 and is now worth some $60,000, according to Blythe's report. Houston is planning a municipal development, as are Galveston, and Corpus Christi on the Gulf, Memphis on the Mississippi and Charleston, S. C.

New York City Increases Pay of Its Employees.—Salary increases to 28,000 employees of New York City who are now receiving $3,640 a year or less, were voted June 27 by the Board of Estimate, to become effective on Sept. 1. Though approximately 10,000 members of the Street Cleaning Department will share the benefits of this action, the greater number of its beneficiaries are enrolled in that class commonly known as white collar workers. The aggregate cost to the city of these increases, it is estimated, will be from $4,250,000 to $4,276,000 yearly.

Sewage Plants and Mosquito Propagation

Relation of Plant Operation to Mosquito Breeding

By JOHN P. PETERSON

Superintendent, The Bergen County Mosquito Extermination Commission, Hackensack, N. J.

IN Bergen County we have closely watched the growth of the county from a cluster of small hamlets to a county of some 350,000 population, and during the growth we have noticed considerable changes in the method of sewage disposal, and the changes were all for the best. While these modern changes were being made in respect to sewage treatment plants, we, of the mosquito control forces, were busy draining swamps, ditching and diking the salt marshes and oiling the city dumps, and paying little attention to areas in the vicinity of the Imhoff tanks. During the past few years we reached a point in our drainage program where we felt we should be getting good results from our labors, only to find that the streams and ponds which we thought to be pure and wholesome were actually breeding large numbers of mosquitoes. We not only found the streams and ponds breeding but also the smaller pools and pockets adjacent to the streams. Close inspections in every case brought out the fact that the water was receiving effluent from a disposal plant.

We also found that some streams had an accumulation of from 6 in. to 8 in. of silt deposited on the bed of the water course. This tended to raise the flow line and consequently, after a heavy rain, would flood the banks and leave pools and pockets of sewage charged water in the swamps alongside of the streams, which in turn would become an ideal breeding place for the Culex Pipien.

These facts were reported to the Commissioners, and they suggested that a survey be made to determine the relation of sewage treatment plant operations with the propagation of mosquitoes.

What the Survey Showed.—The survey brought out the fact that of 42 plants in Bergen County 18 were directly responsible for mosquito breeding in waters receiving effluent from disposal plants, that nine were indirectly responsible and that 14 were not causing breeding and in one case no effort was made to clarify the sewage. This last mentioned case consists of the waste of some 200 employees of a railroad shop, plus the run-off of a large laundry. This untreated sewage runs into an open ditch some 8,000 ft. in length and finds its way to the Hackensack River. This case, however, has no bearing on the subject, as it is direct pollution.

In making our survey we covered each plant in the county and made brief notes as to conditions found. I will not attempt to discuss the findings in each case but will mention a few to give you an idea of what we have to contend with in our efforts to control mosquito breeding.

Conditions at Some of the Plants.—First: The sewage treatment plant in town A was built in 1926. It is composed of digestion and sprinkler systems sufficient in size to handle 25,800 people. The present population using the plant is 5,260. The outlet for the plant is a drainage ditch, 2½ miles in length, with no dry season flow.

At present the plant discharges effluent that is cloudy and holds large amounts of solids in suspension. In 12 months, 18 in. of solids were deposited on the bottom of the drainage ditch. This placed the drainage factor of the ditch at a minimum, and large areas, heretofore dry, were flooded with polluted water. A grave mosquito problem presented itself and the burdens of the expense placed on the mosquito commission. The seven acres of flooded meadow, in this case, supplied mosquitoes for five surrounding communities.

Second: In the town of N there is located a small lake of some 10 or 15 acres, and prior to 1925 was considered an ideal swimming pool, a place where one could linger and fish. Our inspectors, however, made weekly inspections of this lake and not until 1926 did they report any mosquito breeding. Breeding was reported throughout the season and an effort to control breeding here with oil was futile due to the width of the lake and the heavy growth of water plants. In 1927, heavy breeding was reported during the months of July and August, and we had the same trouble as the year previous. In 1928, conditions became so bad that it was necessary to open the sluice gate and drain the lake, with the result that the water which furnishes power for the mill at the lower end of the lake was unable to function for a period of three days. Due to this loss it was impracticable to ask the owner to again open the sluice when breeding re-occurred.

The pollution of this lake is caused by a sewage treatment plant located about 1½ miles further upstream.

Third: This plant was constructed in 1916 and we found little to complain of until 1926 when, due to overtaxing, heavy material was discharged from the drying beds direct to the open meadow, and in 1927, this condition became worse. In 1928 some 3 or 4 acres of meadow land was affected and heavy breeding was found throughout this area. This condition is in close proximity to several towns with a population of approximately 16,000.

Fourth: This plant is located some 1,500 ft. from the water and the effluent is run from the tanks to the creek through pipes. Due to leaks in the joints of the pipes considerable sewage is deposited over the surface of the meadow and with each high tide it is spread in all directions through a heavy growth of cat-tails. Heavy breeding is found within a 1,000 ft. of the pipe, while further away little or no breeding is found in the tide water that covers the meadows. This plant is near three large towns and we have received numerous complaints due to the prevalence of mosquitoes.

In bringing this paper to a close, I wish to demonstrate that the effluent from a plant that is overtaxed or improperly operated is a factor in mosquito control, in so far as it not only stimulates the breeding of mosquitoes in the water that receives the effluent but also tends to create new breeding places by clogging the streams with sediments and causing the water to flood adjacent lowlands.

Acknowledgment.—The foregoing is an abstract of a paper presented at the recent meeting of the New Jersey Sewage Works Association.

Treatment of Laundry Wastes

The original subsidence tank at the waste treatment plant of a laundry in Maryland was converted into an agitation and subsidence tank by placing an ordinary wagon wheel at the base of a vertical shaft so that the contents of the tank can be thoroughly stirred as the chemicals are applied to the raw method. From this tank the effluent passes to a secondary subsidence tank, thence to a cinder and gravel oxidizing bed, the overflow from which passes through a sand filter. The laundry operates three days a week and discharges approximately 1,000 gal. per hour. Studies at this plant were begun in 1927 by the Bureau of Sanitary Engineering of the Maryland State Department of Health, and were continued in 1928. According to the recently issued report of Abel Wolman, Chief Engineer of the bureau, experiments were carried on with different coagulants and at the end of the year the most satisfactory results were obtained with 7.2 grains per gallon of chlorinated copperas and 15 grains per gallon of sulphuric acid. This treatment produced a clear effluent, of a slightly greenish color, from the sand filter.

Reduction of Carbonate Hardness by Lime Softening

Results of the Excess Lime Recarbonation Process

By CHARLES P. HOOVER and JAMES M. MONTGOMERY

Chemist in Charge, Water Softening and Purification Works, Columbus, O.; Manager, Water Works, Piqua, O.

THE purpose of this paper is to describe a process by which the carbonate hardness can be reduced to the solubility limit of calcium carbonate and magnesium hydroxide.

Chemical handbooks usually record the solubility of calcium carbonate as being 13 to 20 parts per million and magnesium hydrate as being 1 part per million or, in terms of calcium carbonate, 1.7 parts per million.

These figures represent the limit to which carbonate hardness can be reduced by lime softening. In actual practical use of this process, results as low as 17 parts per million have been obtained.

The Excess Lime Recarbonation Process.—The process to be described has been in continuous use at Piqua since June, 1927, and has since been used at Columbus, Marion, Delaware, Greenville, Newark and other Ohio plants.

If lime is added in sufficient excess it will not only convert the bi-carbonates to normal carbonates, but will precipitate practically all of the magnesium salts as magnesium hydroxide. The excess lime required to precipitate the magnesium compounds to the lowest possible limit has been found at Columbus and Piqua to be that amount necessary to give the water a caustic alkalinity of approximately 40 parts per million. The caustic alkalinity or excess lime is determined on samples of water taken at the outlets of the mixing tanks. Lime softening reactions may not be entirely completed upon leaving the mixing basins and as these reactions depend largely on the temperature, the sufficiency of the dosage is more accurately determined if the samples are heated to 50° C. and filtered through paper filters before the titration for excess lime is made. After heating and filtering the sample a 100 c.c. portion is titrated with N/50 sulphuric acid, using phenolphthalein as an indicator. When the end point is reached, methyl orange indicator is added and the titration continued to the end point. Twice the alkalinity to phenolphthalein should exceed the methyl orange alkalinity by approximately 40.

The following is a typical analysis of water from the mixing tanks at Columbus and Piqua:

Total alkalinity	68
Phenolphthalein alkalinity	51
Caustic alkalinity	36

After the bulk of the precipitate has settled out, the water should be recarbonated. Montgomery* discovered that recarbonation should be continued to the point where the total alkalinity minus two times the phenolphthalein alkalinity equals approximately 5. For example:

Total alkalinity	53
Phenolphthalein alkalinity	24
Caustic alkalinity	0

If water softened and recarbonated as described is allowed a long reaction period as at the Marion, Ohio, plant, or if it is filtered through conventional type sand filters the alkalinity will drop to about the solubility limit. Recarbonated water of the above analysis filtered through the Columbus filters showed the following results:

Total alkalinity	22
Phenol alkalinity	11
Caustic alkalinity	0

The average results at Piqua in May, 1929, are shown in Table I.

The Advantage of the Process.—(1) Carbonate hardness can be reduced to practically the theoretical limit.

(2) Consistent reduction in hardness can be made irrespective of temperature.

(3) Cost of softening is reduced.

(4) Carbon-dioxide content of softened water reduced; and,

(5) Removal of magnesium according to Graf† eliminates much of the scum left in pans and bath tubs by the reaction of the water with soap.

Effect of Temperature on Process.—The reduction in carbonate hardness by this process is much less influenced by the temperature of the water than by the conventional type softening process. The following are typical results obtained at Piqua, while treating cold river water in freezing weather and relatively warm river water in the summer time (see Table II):

Cost of This Process of Removing Hardness as Compared to Removing It with Soda-Ash or by Zeolite Treatment.—During the 19 years of operation of the Columbus plant before recarbonation, the alkalinity of the softened filtered water averaged 55 parts per million with 5 parts per million of caustic alkalinity or excess lime. Very close supervision of operation is required to reduce the carbonate hardness to the theoretical solubility limit. It is not, however, especially difficult to control the process so as to reduce the carbonate hardness to say 30 parts per million. At the Columbus plant the average carbonate hardness of the filtered water during the past three months has been 30 parts per million instead of 55 parts per million as a general average over 19 years. The difference between 55 parts per million and 30 parts per million is 25 parts per million. In other words the hardness removed because of the use of the process amounts to 25 parts per million. To accomplish this 1.7 grains of additional lime are required. 1.7 grains equals 243 lb. per million gallons and at $6.71 per ton, amounts to 81 ct. per million gallons. If this hardness was not removed by the use of this process, then to meet the standard of hardness maintained at the Columbus plant, it would be necessary to remove the equivalent of this hardness with soda-ash or by the use of zeolite. To remove 25 parts per million with soda-ash at $27.62 per ton, the cost per million gallons amounts to $3.14. The saving per day, indicated by these large scale operations at Columbus, is the difference between $3.14 and 81 ct. multiplied by 30 million gallons per day, or $69.90.

To remove 25 parts per million with zeolite 0.35 lb. of salt per 1,000 grains hardness removed and salt at $6.50 per ton, the cost per million gallons amounts to $1.67. In addition to the cost of salt there would also be some extra expense for wash water.

Recarbonation Decreases the CO_2 Content of the Water.—The question is often asked: Will the addition of CO_2 gas required to recarbonate water increase its corrodibility? The answer is

*Ohio Conference on Water Purification, 7th Annual Report.

†Private communication.

Table I

	Raw	Outlet Mixing tanks	Recarbonated*	Settled	Filtered
Methyl alkalinity	145	64	70	54	22
Phenol alkalinity	0	49	30	25	9
Caustic alkalinity	0	35	0	0	0
Total hardness	165	93	98	83	52
Magnesium	20	....	....	....	2

*Water recarbonated at outlet of Dorr Clarifier ahead of settling basins.

Table II

Jan. 1, 1928
Water Temperature, 38° F.

Raw Water		Filtered Water	
Total alkalinity	119	Total alkalinity	22
Total hardness	145	Phenol alkalinity	9
Magnesium	15	Total hardness	54
		Magnesium	2

June 14, 1929
Water Temperature, 72° F.

Raw Water		Filtered Water	
Total alkalinity	187	Total alkalinity	20
Total hardness	210	Phenol alkalinity	9
Magnesium	20	Total hardness	48
		Magnesium	2

no, unless not applied as hereinbefore related. There is less carbon-dioxide in the water so softened than in uncarbonated softened water as previously softened at municipal water softening plants. That is of course not true where the excess lime and soda treatment is practiced as by railroads and industrial plants.

To explain why there is less free CO_2 in overtreated recarbonated water than in ordinary softened water without recarbonation, it is necessary to explain that CO_2 may exist in water in three forms. Free, half-bound and bound. For example: The average alkalinities of the filtered water at Columbus, for the past 19 years were as follows:

Total alkalinity	55
Phenolphthalein alkalinity	30
Caustic alkalinity	5

This water contained CO_2 as follows:

Free CO_2	0
Half-bound	0
Bound	22
Total	22

The softened recarbonated water at Columbus on March 24, 1929, using excess lime followed by recarbonation shows CO_2 as follows:

Free Co_2	0
Half-bound	.9
Bound	10.1
Total	11.0

In other words, the second analysis on recarbonated water shows only half as much CO_2 as the first analysis of water which was not recarbonated.

Disadvantages of Process.—Recarbonation was developed for the purpose of stabilizing lime softened water.

Filter sand incrustation, deposits in mains and meters in Columbus has already been described.**

The question now arises: Have the benefits of recarbonation as originally used been lost by using it as herein described?

In so far as the operation of the filters is concerned it has.

Effect of the Process on Sand Filters.—As shown by the results given, from 25 to 30 parts per million of hardness is removed by being deposited on the filtered sand. In time the sand grains will become incrusted just as they did formerly at water softening plant before recarbonation was developed. Judging from the rate of growth of the filter sand at Piqua, unless some means of removing the incrustation is employed, it would probably be necessary to replace the sand after about 10 years of operation. It is estimated, however, that even if the sand has to be renewed in ten years, it is still economical to use the process because the saving in softening chemicals will more than pay the cost of sand replacement.

Although the water incrusts the sand grains, the water leaving the filters is apparently stable. After two years of operation at Piqua, several taps were made in the water mains and no incrustation was visible. A number of meters were removed for examination and no deposits were found.

At Delaware, O., where this process is being used and where there is already incrustation in the distribution system, a second dosage of carbon-dioxide is applied to the water after filtration. The purpose of this additional carbon-dioxide is to make the water sufficiently corrosive to dissolve some of the carbonate already in the mains.

Schemes Being Tried to Throw the Burden Off the Filters.—Various methods of removing this burden from the filters are being tried. At Piqua the incrustation has been removed successfully by taking the filter out of service after two or three months' use and then allowing the highly acid water from the carbonation scrubber to flow up through the sand and out through the wash water troughs. After two or three weeks of this treatment the incrustation has been dissolved and the filter is again ready for service.

The calcium carbonate formed by the recarbonation in this method of treatment will crystallize out and settle if sufficient settling time is provided. Tests to determine the minimum time are now being made.

Experimental results indicate that the reaction will go to completion much more rapidly if the softened water is agitated after being recarbonated.

Return of sludge, the addition of coagulating materials and filtration through coarse filtering materials are some other schemes that are receiving attention.

Acknowledgment.—The above is an abstract of a paper presented June 27 at the 49th annual convention of the American Water Works Association.

**Journal of Industrial and Engineering Chemistry, Volume 19, July, 1927.

Piecemeal City Planning

In spite of the rapid development of city planning one of the shortcomings of American municipalities is found to be the lack of a comprehensive plan, by Gardner S. Rogers, city planning expert, Assistant Manager of the Civic Development Department of the Chamber of Commerce of the United States.

"Proper municipal development," he said in an address to the Southern Commercial Secretaries' Association, "is not a series of unrelated projects developed when demanded by necessity or political expediency, but rather one comprehensive project in which each individual part has a definite relation to the whole.

"The builder of an office building would not complete the structure and later tear down walls and partitions to add the necessary plumbing and lighting fixtures, yet many cities lay concrete pavements to be torn up later for the purpose of extending or enlarging water or sewer mains. A large office building would not be located on a farm two miles from the center of population because farm land was less expensive than city property, but school boards have a habit of choosing inexpensive sites on the outskirts of a town and so far from the children that bus lines must be established to collect them.

"Comprehensive city planning as it is understood today is the foundation of all municipal improvement and when properly executed coordinates all phases of municipal work in one comprehensive whole. Such a plan may be divided into four major divisions; thoroughfares, zoning, recreation and the platting of undeveloped property."

City Building

Cities that are allowed to grow wild without regard to the uses made of them are rapidly diminishing in number, it is asserted by the Civic Development Department of the Chamber of Commerce of the United States.

In a publication on "Zoning," which has just been issued, it points out that although zoning did not begin in this country until 1916, when New York adopted the first zoning ordinances, the practice is now almost universal.

"Today," says the foreword to the Chamber pamphlet, "this conception of zoning is understood in nearly every city and village in the country. In less than 15 years more than 700 municipalities have been zoned.

"The present problem, therefore, is not so much one of education as it is one of procedure. What does a zoning ordinance contain? To what extent does it regulate property, and how are these regulations put into effect? How are safeguards provided for so that injustices to property owners will be eliminated? These and other practical questions are here discussed in outline form."

Micro-organisms in the Lake Michigan Water at Chicago

Their Effect on Filtration and Method for Counting

By JOHN R. BAYLIS and H. H. GERSTEIN
Bureau of Engineering, Chicago, Ill.

A RECORD of the Plankton in the Lake Michigan water at Chicago was thought to be of some value in determining how long each year we may expect short filter runs when the filtration plants are constructed. The Division of Water Safety Control, Bureau of Engineering, has collected samples from the various intake tunnels for microscopical counts during the past several years. The counts have been made at the Chicago Department of Health. At first samples were collected five times each week, but now they are collected only three times weekly. Since starting operation of the experimental filtration plant, microscopical test of the water from the Dunne crib have been made at this plant in addition to those made by the Health Department.

Fairly reliable record of the organisms occurring in the water entering the Chicago intake cribs for the past two years is now available. The prevailing class of organisms is diatoms, the other algae may occur in abundance occasionally. The monthly average of the volume of all organisms is shown in Fig. 1. It will be noted that the peak for 1927 was in May and for 1928 it was in September. It is interesting to note that in 1928 the minimum monthly average was nearly one-half the maximum. It probably is unusual for water in the northern part of the United States to have a January and December volume of organisms of about 500 cubic standard units per cc. (a cubic standard unit is a cube 20x20x 20 micra). The temperature of the water is shown in Fig. 2, and the hours of sunshine are shown in Fig. 3.

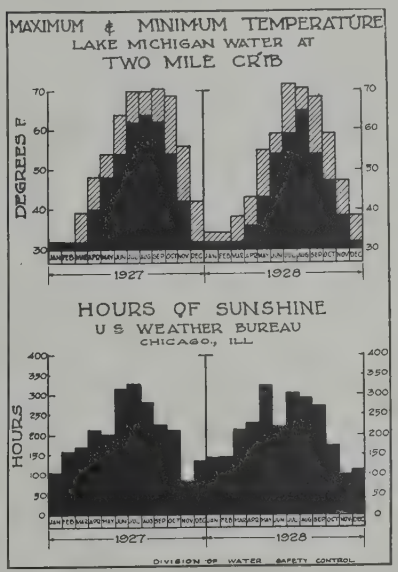


Fig. 2 Upper, Fig. 3 Lower

Figures 4, 5, 6, 7, 8 and 9 show the monthly averages of the 6 organisms occurring in fairly large numbers. It will be noted that Tabellaria may grow abundantly at most any season of the year. It was high from April, 1927, to February, 1928; also high again in October, November and December, 1928. Asterionella usually has its peak in the spring. The peak for Fragillaria seems to occur at most any time of the year. Nitzchia and Melorira usually have their peaks in the spring. Dinobryan, and perhaps most animal organisms, usually have their peaks in the summer or fall. It will be noted from Table I that no animal organism occurring in fairly large number had its peak in the espring. It also will be noted from Table I that the day of highest volume usually occurred in the spring or summer for the diatoms and in the latter part of the year, from August to December, for the green algae. The counts at the experimental plant correspond fairly well with the counts made by the Health Department.

Tastes and Odors. — Objectionable tastes and odors have not occurred in the Chicago water as often as might be expected from the large number of organisms present. There seems to be no reliable information as to how many organisms of the taste-producing kind are necessary to impart a taste to water. If there are 200 or 300 cubic units of a certain organism present we have little information as to whether this is near the taste-producing point or whether the water may contain many more without danger of taste or odor. The writers therefore can give very little information along this line.

There have been several periods during the past few years in which there were tastes readily noticeable in the Chicago water. The following is taken from the 1926 report of the Division of Water Safety Control:

"Beginning about the first of July, 1926, and continuing for over three weeks there was a marked grassy to objectionable fishy taste in the public water supply throughout the city. The cooperation of the U. S. Public Health Service was enlisted in studying the cause of this condition. Assistant Limnologist Milton S. Foreman, attached to the Stream Pollution Office of that service at Cincinnati, O., was detailed by the Surgeon General on July 15 to assist in the investigation. The most offensive condition existed between July 7 and 10, during which time hundreds of complaints were received from citizens in all sections of the city. Continuing throughout the summer, and even as late as the first week in Sep-

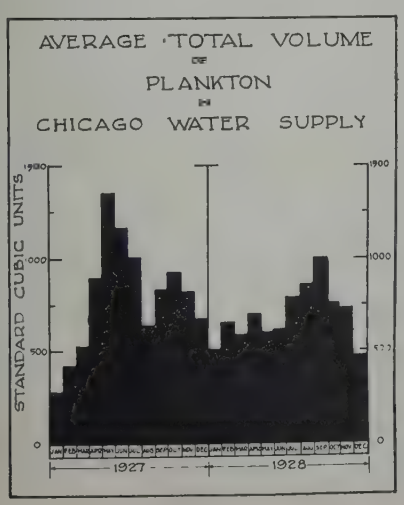


Fig. 1

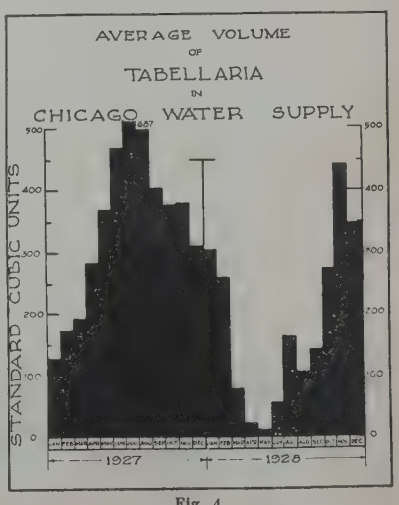


Fig. 4

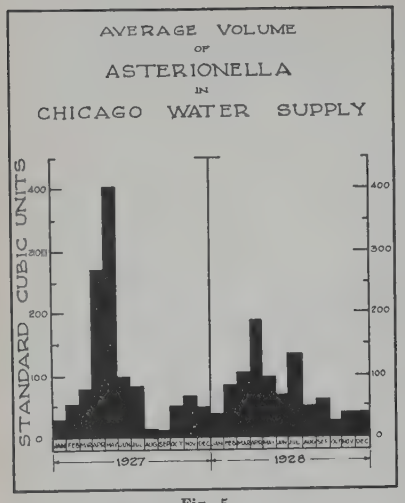


Fig. 5

tember, a noticeable grassy to fishy taste persisted in the water supply."

The microscopical counts during the days of excessive taste showed the presence of about 250 cubic units of Dinobryan per cc. At this time the entire volume of the cluster of organisms was measured, consequently the volume given was greater than the true volume.

The 1927 and 1928 reports each record a period of taste. "There was a noticeable fishy taste in the water in July, 1927, and in the early part of August, which was attributed to the presence of large numbers of Tabellaria." From the 1928 report there is the following: "During the first few days in July a taste was noticed in the water supply which was probably caused by the marked increase in Dinobryan."

Effect of Micro-organisms on Filtration.—It is not necessary to tell most filter operators that microörganisms cause a shortening of the filter runs, for this is the most serious operating trouble in many plants. Many perhaps are already familiar with how the organisms actually cause short filter runs, but there is little specific information in the water works literature on the subject. One of the writers (Baylis) has made observations for a number of years on the things that affect filter runs, which, it is hoped, will throw a little more light on the subject.

First we should consider how a sand filter actually removes the suspended matter from water. In this paper the discussion will be limited to water that has been coagulated as is customary practice in rapid sand filtration. It is evident that the voids in the sand bed of a rapid sand filter are much larger than many of the particles of coagulated matter, yet all the particles are filtered out without difficulty. This is due largely to a lodgement of the particles in the wedge of the void where two sand grains touch. Ordinarily there is considerable penetration of the coagulated matter into the sand beds when sand of about 0.3 mm. diameter or larger is used. This is what we hope to accomplish, for when the filtration is largely on the surface of the sand bed the loss of head increases very much more rapidly than if the coagulated matter penetrated into the bed. Figure 10 shows typical loss of head curves where there is penetration into the bed and where the filtration is largely in the surface of the bed. It will be noted that the curve when there is penetration is nearly straight whereas the one where the filtration is largely in the surface layer the curve keeps increasing at an accelerated rate.

Certain microörganisms add toughness to the coagulated matter. It is somewhat like adding steel reinforcing to concrete. As the coagulated matter filters out it forms a mat on top of the sand bed so tough that the increasing pressure to keep the filtration rate

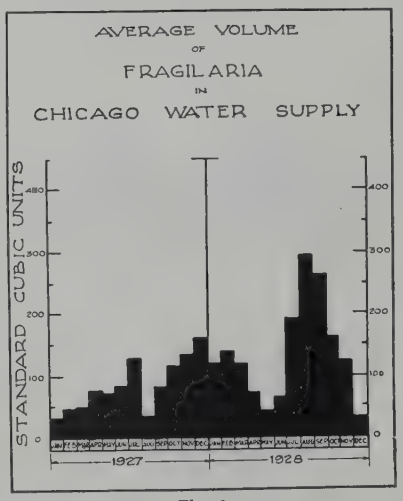


Fig. 6

constant does not force it through the voids in the sand at the surface as is the case where no organisms are present. Figure 12 shows camera lucida drawing of coagulation containing entrapped microörganism, and Fig. 13 shows the more compact mat formed on the filter surface. It is evident that the mat actually formed at the filter surface is much thicker than that shown by Fig. 13, but a thin section that would allow light to pass through had to be used for making the drawing. The mat will vary in toughness with the kind of organism present. Long filamentous organisms are more effective in adding toughness to the coagulated matter than the short or spherical organisms. In most instances when extremely short filter runs occur filamentous organisms are the main cause, however an enormous increase of certain organisms like Asterionella or Tabellaria may cause very short runs.

There are instances where spherical or nearly spherical organisms have been thought to be the cause of the short runs. Some organisms of this kind appear to break up and form a gelatinous substance in the water that is much tougher than the gelatinous precipitate of alumina or iron. There are also instances where a comparatively small volume of the organisms reach the filter beds, yet the runs are short. This is believed to be due largely to the presence of gelatinous matter that results from the decay or breaking up of the organisms back in the reservoir before the water reaches the filtration plant.

There are two ways in which filter runs may be lengthened when microörganism are the cause of the short runs. The organisms must be removed before the water reaches the filter beds, or the water must be filtered through a bed of coarse material before going to the main sand filters. It might be possible to add a few inches of light coarse material on top of the sand and produce somewhat the same results as double filtration. The coarse material should contain voids large enough that a mat cannot form on the surface, yet it must be capable of removing a large percentage of the coagulated matter.

It is believed that sedimentation offers the most practical means of removing microörganisms in most instances. Where the water goes through storage reservoirs of several days capacity prior to chemical treatment and filtration, chlorine or copper sulphate may be used to kill the organisms. Then many of them will gradually settle to the bottom. When it is not possible to do this and it is necessary to take the water as it comes to the plant a quick settling flocculation must be produced. This may be done by adding suspended matter to the

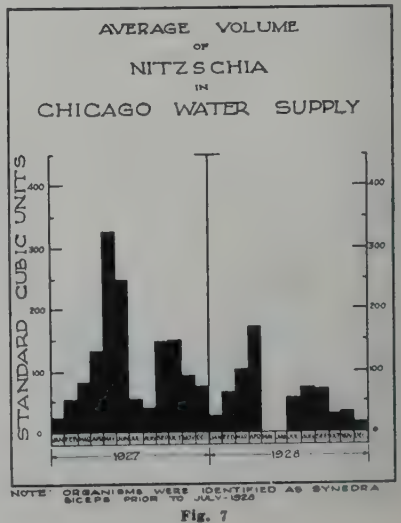


Fig. 7

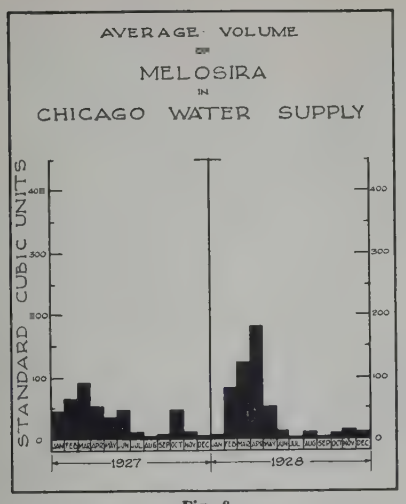


Fig. 8

water as Lovejoy[1] has done at Louisville by the addition of an excess of coagulant, or the production of an artificial turbidity by softening with lime. Local conditions will largely determine the most effective means of handling the situation. The point that should be stressed is that all plants subject to short filter runs should be prepared to handle the situation in some manner and not let the filtration plant operate at decreased efficiency part of the time.

Most of the plants handling the Great Lakes waters are troubled with microörganisms producing short filter runs part of the time. Usually a storage reservoir of a few days capacity separate from the lake is not provided. The organisms probably can be handled best by precipitating them with the coagulated matter. The organisms themselves have very little tendency to settle, or they would not be in the water. Aluminum hydroxide coagulation also is very light and does not settle rapidly even though an excess is used. To produce a rapidly settling coagulation there must be an increase in the turbidity. This may be done by adding mud to the water, or by forming a crystalline precipitate in the water. The fact that the Great Lakes water is fairly hard and is already saturated or nearly saturated with calcium carbonate, it seems that the most economical thing to do is to add lime to the extent of producing a calcium carbonate precipitate that will increase the turbidity to 50 or more.

Method for Counting.—The Chicago Health Department laboratory uses the procedure as outlined in Standard Methods of Water Analysis, except that coarser sand is used for filtering the water. This is due to the difficulty in filtering through the desired amount of the sample within a reasonable time. To avoid this trouble and to eliminate the error in concentrating, the experimental filtration plant makes a direct count without concentrating unless the counts are very low. This procedure will be outlined.

[1]Lovejoy, W. H. Algae control by creating turbidity at Louisville, Ky. Engineering News-Record, Vol. 101, No. 14, Oct. 4, 1928, pp. 505-507.

Table I—Micro-organisms in Chicago Water Supply, 1927-1928

Organisms	Maximum Monthly Average Average of All Cribs Cubic Std. Units	Date	Maximum Daily Occurrence Cubic Std. Units	Date	Crib
Diatoms—					
Tabellaria	687.4	July, 1927	1452	June 22, 1927	4-Mile
Asterionalle	403.8	May, 1927	1710	May 12, 1927	Harrison
*Nitzchia	328.3	May, 1927	798	May 23, 1927	Wilson
Fragilaria	293.5	Aug., 1928	846	July 23, 1928	Harrison
Melosira	181.5	Apr., 1928	840	Apr. 25, 1928	2-Mile
Synedra	133.9	May, 1927	378	June 1, 1927	Harrison
Rhizosolenia	63.3	June, 1927	342	May 26, 1927	Wilson
Unknown No. 1	43.6	May, 1928	156	Mar. 13, 1928	Wilson
Diatoma	23.5	Aug., 1928	158	Oct. 1, 1928	4-Mile
Amphiprora	13.4	Aug., 1928	210	Aug. 31, 1928	Dunne
Stephanodiscus	12.6	Aug., 1928	101	Aug. 3, 1928	Wilson
Cyclotella	11.5	Apr., 1928	72	Mar. 14, 1927	Dunne
Surirella	9.3	July, 1928	132	Sept. 5, 1928	Dunne
Pleurosigma	8.2	Aug., 1928	60	Aug. 24, 1928	Harrison
Navicula	5.7	Mar., 1928	102	Feb. 23, 1928	Harrison
Amphora	4.7	Nov., 1928	60	July 27, 1928	2-Mile
Epithemia	3.1	Mar., 1928	150	June 27, 1928	Wilson
Cymatopleura	1.8	Oct., 1927	18	Oct. 10, 1927	Harrison
Green Algae—					
Ulothrix	18.8	July, 1928	121	Aug. 8, 1928	Dunne
Spirogyra	10.1	Sept., 1927	96	Sept. 12, 1927	4-Mile
Merismopedia	7.2	Nov., 1927	150	Nov. 2, 1927	4-Mile
Coelosphaerium	6.0	Oct., 1927	600	Oct. 21, 1927	Wilson
Pediastrum	5.1	Nov., 1928	300	Nov. 10, 1928	Harrison
Dimorophococcus	2.6	Nov., 1927	180	Jan. 5, 1928	4-Mile
Anabaena	2.5	June, 1927	60	June 30, 1927	2-Mile
Dictyosphaerium	2.3	Oct., 1927	150	Nov. 3, 1927	Wilson
Protococcus	1.3	Jan., 1928	72	Dec. 8, 1927	Harrison
Gloeocystis	1.2	Jan., 1928	90	Jan. 27, 1928	Harrison
Actinastrum	.9	Dec., 1928	42	Dec. 4, 1928	Harrison
Ankistrodesmus	.5	Oct., 1927	30	Oct. 14, 1927	4-Mile
Staurastrum	.3	Sept., 1928	18	Sept. 26, 1928	Wilson
Chroococcus	.2	Nov., 1927	18	Nov. 15, 1927	4-Mile
Myxonema	.1	May, 1927	10	May 20, 1927	4-Mile
Desmidium	.01	Jan., 1927	1	Jan. 1, 1927	Wilson
Protozoa—					
Dinobryon	135	Oct., 1927	522	Nov. 1, 1927	Wilson
Ceratium	58.6	Sept., 1927	540	Oct. 5, 1928	4-Mile
Vorticella	10.7	Dec., 1927	1008	Dec. 16, 1927	Harrison
Acineta	10.5	Oct., 1928	732	Oct. 1, 1928	Wilson
Difflugia	5.8	Aug., 1928	90	Aug. 29, 1928	Dunne
Synura	3.8	Nov., 1927	72	Nov. 25, 1927	Harrison
Uroglena	3.0	Sept., 1928	96	Oct. 31, 1927	Dunne
Nassula	1.1	Aug., 1928	72	Aug. 17, 1928	Wilson
Carchesium	.9	Sept., 1927	4	Oct. 6, 1927	Wilson
Amoeba	.8	May, 1927	24	June 8, 1927	Harrison
Glenodinium	.7	Sept., 1928	18	Sept. 12, 1928	Dunne
Actinophrys	.3	Nov., 1927	24	Nov. 16, 1927	4-Mile
Mallamonas	.2	July, 1928	14	July 17, 1928	Dunne
Rotieera—					
Anuraea	96.9	Sept., 1928	900	Aug. 27, 1928	Wilson
Polyarthra	89.8	Aug., 1928	1680	Aug. 31, 1928	2-Mile
Brachionus	5.3	Sept., 1928	240	Sept. 21, 1928	Harrison
Diaschiza	2.6	Sept., 1928	144	Sept. 19, 1928	Dunne
Crustacea—					
Cyclops	115.8	Sept., 1928	3972	July 25, 1928	Harrison
Daphnia	109.1	Sept., 1928	1200	Sept. 24, 1928	2-Mile
Bosmina	32.1	July, 1928	1884	July 28, 1928	Harrison
Coelenterata—					
Hydra	125.7	Oct., 1928	8800	Oct. 24, 1928	Harrison
Aquatic earthworms	201.0	May, 1928	90	July 15, 1927	Wilson
Aquatic roundworms	.5	June, 1927	48	June 2, 1927	Dunne

* Prior to May, 1928, Nitzchia was identified as Synedra biceps.

For counting the small organisms, 1 cc. of the water is placed in a Rafter's counting cell and allowed to stand about 10 minutes before starting the count. Practically all the organisms settle to the bottom of the cell within this time. There are a few species that float and will come to the top of the cell, but such organisms are rarely present in most waters. The count is made by focusing the microscope on the bottom of the cell and starting at one end. The cell is moved gradually towards the other end with the mechanical stage and the organisms are counted and measured as they are passed over by the ruled portion covered by the eyepiece micrometer. This should be repeated across the cell until a sufficient number of organisms have been counted to give fairly good indication of the number present. In addition to this it is desirable to go across the cell a few times with the focus at the top so that floating organisms will not be missed. If the magnification is such that the ruled

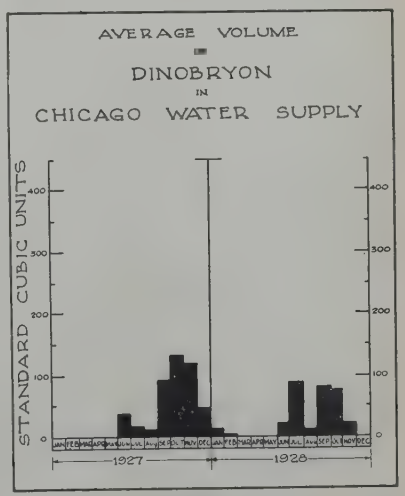
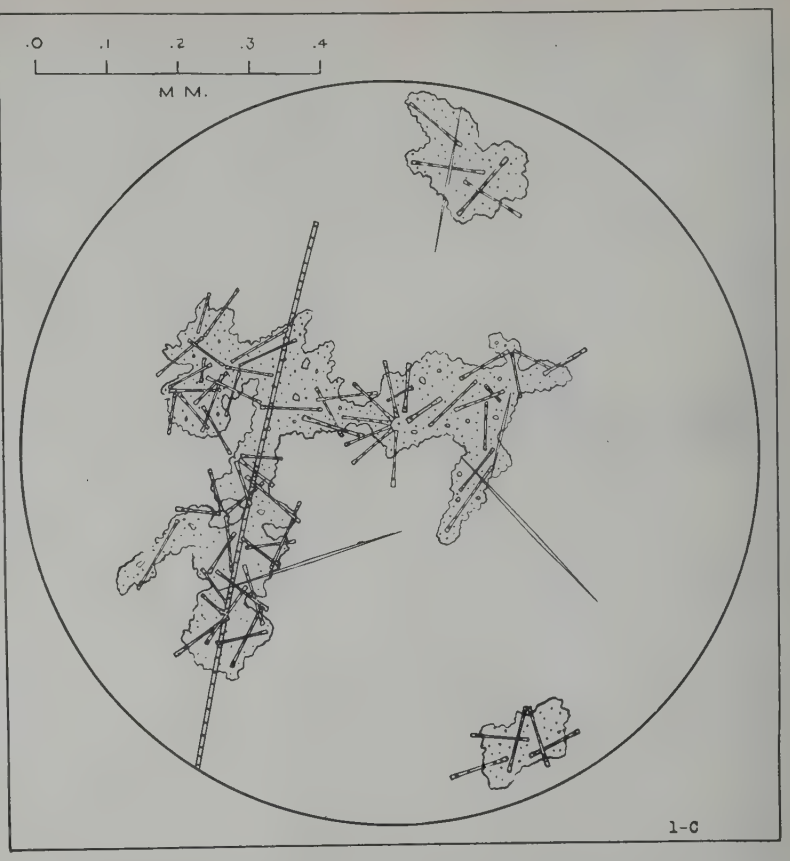


Fig. 9

Table II—Comparison of Direct Count with Samples Concentrated by Filtration

Date	Direct Count		Concentrated by Filtration	
	No. of organisms per CC.	Cubic standard units per CC.	No. of organisms per CC.	Cubic standard units per CC.
8-31-28	676	184	306	149
9- 6	276	113	378	91
9-25	465	236	420	136
9-27	1,010	429	570	175
9-28	785	303	845	438
10-1	656	261	486	212
11-21	1,690	273	1,350	565
1-25-29	310	230	240	115
1-30	201	116	240	80
1-31	140	136	210	87
2-1	248	181	372	280
2-7	292	126	180	99
2-14	212	119	444	211
2-27	340	146	300	108
2-28	220	90	372	141
3-1	389	315	300	58
3-6	640	227	450	137
3-8	540	226	516	128
3-15	128	44	240	117
3-19	335	170	324	61
3-21	368	83	246	64
3-22	241	105	348	130
3-27	449	122	366	150
3-28	449	174	222	113
3-29	550	273	126	43
4-2	1,320	416	1,764	877
4-4	285	194	480	94
4-9	666	175	510	113
4-10	690	185	702	221
4-11	1,040	282	1,008	256
4-16	4,160	886	2,976	658
4-17	4,220	810	3,120	571
4-18	5,580	1,279	4,224	826
4-23	3,520	796	3,240	713
4-24	5,700	1,130	4,040	688
4-25	6,050	1,150	5,400	1,060
4-26	5,050	1,090	2,840	592
Average	1,351	353	1,085	285

portion covers one square millimeter, passing from one end of the cell to the other (the cell is 20 mm. wide and 50 mm. long) is one-twentieth of a cc. When the counts are high, passing across the cell once may be sufficient, but when only a few are present it may be necessary to examine the entire cc. of water. In fact when there are less than 25 organisms present the samples should be concentrated.



MICROÖRGANISMS ENTANGLED IN ALUMINUM HYDROXIDE COAGULATION
Fig. 12

The examination for large organisms is made by concentrating and examining in a 10 cc. cell. This cell is 50 millimeters long, 40 millimeters wide, and 5 millimeters deep, inside dimensions. It is constructed in the same manner as the Rafter's cell. Instead of filtering the water through sand No. 20 silk bolting is used, being made in the form of a cylinder about 4 in. long and ½ in. in diameter. This is attached to the bottom of the filtering funnel and the desired amount of water filtered through. The water passes through the cloth quite rapidly and most any amount desired may be filtered within a very short time. When a large number of large organisms are present 2 to 5 liters are filtered.

After the water has filtered through, the plug on the bottom of the cloth cylinder is removed and the catch washed through with slightly less than 10 cc. of water. It is then diluted to 10 cc. and placed in the large counting cell. The 48 mm. objective is used and the procedure for counting and estimating the volume is the same as for the small cell, except there is a different factor for the area covered by the ruled portion. It may be necessary to kill the organism to prevent them from moving about while the count is being made. As a rule only such organisms as measure about 150

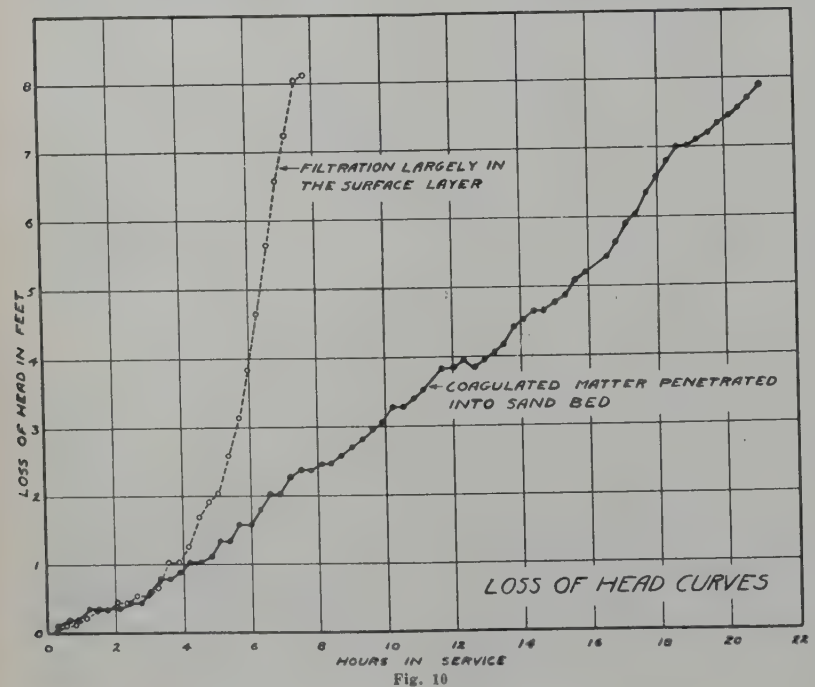


Fig. 10

Table III—Volume of Organisms in Cubic Standard Units

Diameter in micra	Spherical	Cylindrical 100 micra in length
1	.000	.01
2	.001	.04
3	.002	.09
4	.004	.16
5	.008	.25
6	.014	.35
7	.022	.48
8	.033	.63
9	.048	.80
10	.065	.98
11	.087	1.19
12	.113	1.41
13	.143	1.66
14	.180	1.92
15	.221	2.21
16	.268	2.51
17	.322	2.84
18	.382	3.18
19	.449	3.54
20	.524	3.93
22	.697	4.75
24	.905	5.65
26	1.150	6.64
28	1.437	7.70
30	1.767	8.84
32	2.141	10.05
34	2.572	11.35
36	3.054	12.17
38	3.591	14.17
40	4.189	15.71
45	5.964	19.88
50	8.181	24.54
60	14.144	35.34
70	22.449	48.11
80	35.510	62.83
90	54.257	79.52
100	65.449	98.17

To obtain the volume of organisms with diameters larger than is shown by the table, look for the volume one-tenth the diameter and move the decimal point three places to the right for spherical organisms and two places for cylindrical organisms.

micra or more in diameter are counted. This will include Daphnia, Cyclops, Hydra, Bryozoa, large protozoa and rotifiers, worms, etc. Daphnia and Cyclop frequently occur in numbers that cause a shortening of the filter runs, yet the procedure as outlined in Standard Methods of Water Analysis does not insure an accurate estimate of the number and volume of such organisms. The method of concentrating by filtering through cloth was developed by John H. Mills, bacteriologist at the experimental plant.

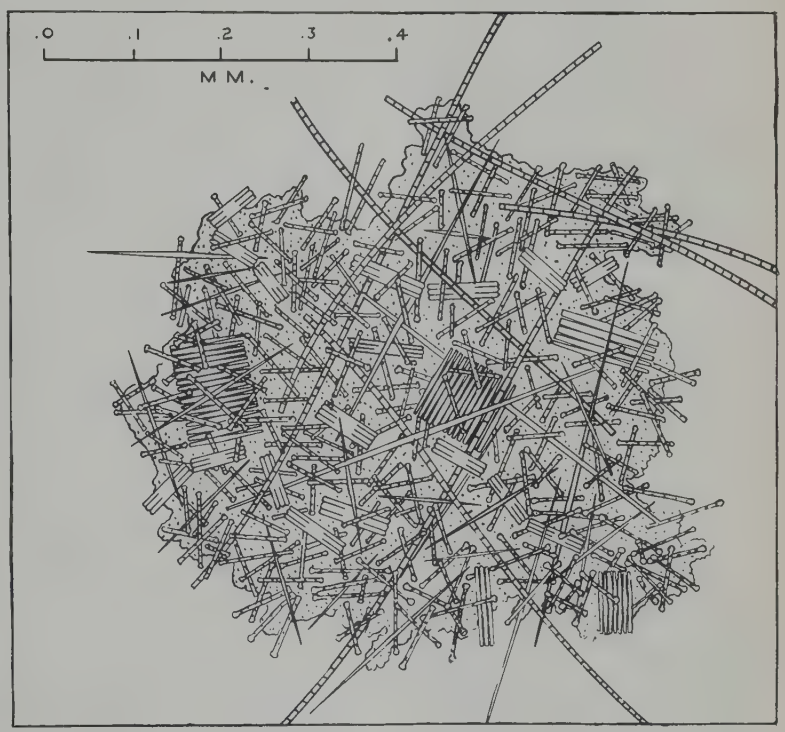
One of the writers (Baylis) has used the direct method of counting for a number of years and prefers it to concentrating the samples. It is more accurate and usually involves less labor than the concentration method. Table II shows comparison of the direct count with the concentration method as outlined in Standard Methods. It is seen that the direct count gives a slightly larger number of organisms.

It is believed desirable to state how the measurements of the organisms are made, especially as there seems to be no uniform procedure for such measurements and different workers may vary greatly in the volume measurement for certain species of organism. Some workers will take the entire area within the circle of a characteristic spoke-wheel cluster of Asterionella cells, whereas the actual volume is the sum of the volumes of the individual cells. A cluster of Dinobryon is sometimes measured as the outside dimension of the cluster, yet it is evident that the true volume is that of the cells only. With the various procedures now used it is difficult to compare the results from two laboratories. The procedure as used by Baylis will be given.

The volume in cubic standard units for various size organisms is given in Table III. It provides for measuring the organism as a sphere or cylinder. If the organism is nearer a sphere than a cylinder its spherical diameter is estimated and the volume obtained directly from the table. If its length is considerably greater than the diameter it is measured as a cylinder. The length and diameter are determined and the column for cylindrical organism used. The figures are based on a cylinder 100 micra (0.1 mm.) in length. The volume is quickly computed from the table but is not given unless the length happens to be 100 micra. Assume that an organism is 150 micra in length and the average diameter is 12 micra. The table gives 1.41 cubic standard units for the volume of an organism this diameter 100 micra in length, consequently the total is 2.17 units.

Such organisms as occur in clusters that are easily broken apart are counted one organism for each cell. This includes Asterionella, Dinobryon, Fragellaria, Synedra, Bryozoa, and others. Organisms that occur in filaments such as Melosira, Oscillatoria, Anabaena, Aphanizomenon, Ulothrix, and many others are called one organism per 100 micra of length. A melosira 800 micra in length is recorded as 8 organisms.

A record sheet as shown in Fig. 14 is used. The advantage of this kind of a record becomes apparent. Assume that there are 8 attached cells to a cluster of Asterionella. Eight is recorded as a numerator, and the total volume of the eight cells is recorded as the denominator. One can tell from the sheet just how the Asterionella occurred, for when there is an individual cell it is recorded as one and when there are two or more attached the number is recorded. Such a system of recording is advantageous for recording Asterionella, Fragillaria, Tabellaria, Dinobryon, and in fact all organisms that may occur either single or in clusters. It is particularly advantageous for filamentous organisms, for the length of the filament may be obtained from the record. Assume a filamentous organism is recorded 7.5 organisms and 15 cubic standard units. The organism is 750 micra in length and 15 micra in diameter. The length of the filament has considerable bearing on its effectiveness in causing filter clogging. In studying operating records one may refer to the original sheets and determine the size of all organisms counted.



COMPACT ALUMINUM HYDROXIDE COAGULATION CONTAINING MICROÖRGANISMS.
Fig. 13

Acknowledgment.—The foregoing is

MICROSCOPICAL COUNT

	1 CC.	10 CC.
OBJECTIVE	16 MM.	48 MM.
PORTION EXAMINED	1/10 CC.	10 CC.
CONCENTRATION	0	500
FACTOR	10	.0002

DATE JUNE 21, 1928
SAMPLE TUNNEL FROM DUNNE CRIB
EXPERIMENT No. 11
COUNT BY JOHN H MILLS

COUNT ON 1 CC. CELL

ORGANISM	MEASUREMENT	NUMBER	CUBIC UNITS
ASTERIONELLA	7/1.4 8/1.6 1/.2 1/.2 1/.2 3/.9 1/.2 3/.9 1/.2 8/2.4 1/.2 3/.9 3/.6 6/1.8		
	5/1.0 2/.4 3/.6 1/.2 2/.4 2/.6 6/12 2/.4 1/.3 2/.4 1/.2 5/12 — — —	81	18.0
SYNEDRA	1/.3 1/.2 1/.1 1/.1 1/.1 1/.8 1/.2 1/.2 1/.1 1/.2 1/.2 1/.1 1/.2 1/.2 1/.2		
	1/.3 1/.2 1/.2 1/.3 1/.2 1/.2 1/.2 1/.1 1/.3 1/.5 — — — — —	25	5.7
MELOSIRA	2/1.6 25/200 — — — — — — — — — — — —	27	21.6
FRAGILLARIA	3/.3 3/.4 — — — — — — — — — — — —	6	.9
CYCLOTELLA	1/.1 1/.2 — — — — — — — — — — — —	2	.3
NITZSCHIA	1/3.0 — — — — — — — — — — — — —	1	3.0
NO. 1	1/1.0 — — — — — — — — — — — — —	1	1.0
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
	— — — — — — — — — — — — —		
UNCLASSIFIED	1/.1 1/1.6 1/.1 1/.3 — — — — — — — — — —	4	2.1
	TOTAL	147	52.6
	TOTAL PER CC.	1,470	526.

COUNT ON 10 CC. CELL

ORGANISM	MEASUREMENT	ORGANISM	MEASUREMENT		
CYCLOPS	1/3,000 1/4,000 1/4,000 1/4,500	DAPHNIA	1/1800 1/1600 — —		4.0
	— — — —		— — — —		
			TOTAL PER CC.	1,470	530

Fig. 14

an abstract of a paper presented at the 49th annual convention of the American Water Works Association, held June 24-28 at Toronto, Ont.

Snow Melted in Cooling Pond of Power Plant

The city of Westmount, Que., melts the snow gathered from the city streets and walks in the cooling pond of the municipal power plant. The pond was built for the purpose of cooling hot water from the condensers of the steam plant. To facilitate the melting of the snow, which is dumped from the trucks in which it is collected, steam lines are carried directly from the boilers to the pond where they discharge below the dumping space provided for the trucks. About 40 per cent of this steam is derived from the destruction of garbage and if the heat units so obtained be disregarded, the average cost of melting snow is less than 20 ct. per load of about 9 cu. yd.

Training Schools for New York State Municipal Employees

A comprehensive program for the training of all groups of municipal officials and employees was adopted at a recent meeting of the Advisory Committee of the Conference of Mayors and Other Municipal Officials of the State of New York.

According to the Boston City Record, ten years will be required for putting into effect the complete schedule, which calls for the establishment of training facilities for health, fire, charities and financial officials, civil service employees, water bureau superintendents, purchasing agents, city and village clerks, park officials and assessors.

The conference has plans already under way for the training schools for fire department and charties department employees similar to those now being organized for police training, and the training of health officers is being taken care of by the State Health Department.

Venturi Meter Regulates Flow of Coagulant

A Venturi meter performing a dual role is an interesting feature of the new Huia filter station at Auckland, New Zealand. Water is carried to the filter station by a concrete aqueduct designed for a capacity of 32 m.g.d. The conduit terminates in a Venturi tube having an upstream diameter of 4 ft. 6 in. and a throat diameter of 17 in. In addition to metering the flow, the Venturi serves as a part of the coagulant dosing apparatus.

The upstream end and the throat of the Venturi meter are connected by piping to vertical concrete tubes, in which are placed copper floats. The difference in elevation of the floats is, of course, proportional to the flow through the meter, and this difference is made to control the rate at which the coagulant is admitted. The relative movement of the floats is translated into a vertical movement of a hollow arm. This arm is hinged at its lower end, is fitted with an adjustable orifice at its upper end and is connected to the tank containing the coagulant solution. The solution in the tank is kept at a constant level by means of floats. When there is no flow through the Venturi, the orifice is at the level of the solution and there is no flow of coagulant. As the flow of water increases, the orifice drops an amount proportional to the difference in head between the throat and the upstream face of the Venturi and the dose of coagulant is thus kept constant at all times.

Atlantic City's $15,000,000 Municipal Auditorium Inaugurated.—The recently completed $15,000,000 municipal auditorium of Atlantic City, N. J., was inaugurated with the convention of the National Electric Light Association, in which was staged the largest exhibition of electrical equipment ever assembled under one roof. This convention marks the beginning of the Edison Jubilee, which continues until October.

New York City to Have More Parks.—The Board of Estimate of New York City has authorized the purchase at private sale of prospective park sites in Queens and Richmond with a combined plottage of more than 632 acres at a cost not exceeding $2,250,000, from the $3,000,000 fund recently made available for that purpose.

No General Taxation for This City.—Ponca City, Okla., a municipality of 20,000 population, is stated to have the distinction of enjoying absolute freedom from general taxation. The city owns and operates its water and lighting utilities and the profits therefrom pay the entire running expenses of its municipal government.

Providing Sewer Facilities in Rural Communities

Formation of County Sanitation Districts in Kansas

By E. F. KINDSVATER
Engineer Douglas County Sewer District No. 1, Lawrence, Kan.

CHAPTER 165 of the Session Laws of Kansas for 1927, authorizes "the construction and maintenance of storm and sanitary sewers in counties having a population over twenty-one thousand and less than seventy thousand, provides for the condemnation of necessary land therefore, and provides for the payment of the cost of such sewers." This law represents the first attempt to provide sewer facilities in unincorporated suburban and rural communities.

The Why of Sanitation Districts.—The enactment of this law and the use that will undoubtedly be made of it comes as a result of the tendency in recent years of urban residents to move out into the open spaces surrounding the cities proper when building their homes. It is not only possible for unincorporated areas surrounding the larger cities to take advantage of the law, but also makes it possible for suburban villages to utilize this method in financing sewer improvements which their taxing limitations would otherwise prevent. It further provides a means for forming a district made up of urban and suburban areas, or of several suburban areas for which a system of sewers and sewage disposal could be designed which would treat the entire area as a whole, each local system becoming an integral part. The law may also prove to be of especial service to summer resort communities and tourist camps from which typhoid frequently emanates as the result of bad sanitary conditions. These resorts can now be cleaned up and given modern conveniences by the help of this law.

Douglas County Sewer District No. 1.—A residential area, located immediately west of the University of Kansas campus and not incorporated with the city of Lawrence, found it necessary to provide sanitary sewer facilities to take the place of an old and very much overloaded septic tank system. Douglas County Sewer District No. 1 was, therefore, formed in April, 1928, when the owners representing "fifty-one per cent or more of the acreage in the district" petitioned the board of county commissioners for its formation.

The board of county commissioners, after duly advertising the petition and making it possible for those not signing the petition to file their protests, employed the writer as engineer to prepare plans and specifications, and superintend the construction of a sewer system. Surveys were made, plans and specifications prepared and with application for the creation of Douglas County Sewer District No. 1, submitted to the State Board of Health for approval.

The policy adopted by the board of county commissioners was to make plans and specifications to cover the entire district and to construct only that part which was necessary to relieve the congested septic tank and provide for the immediate real estate development within the district. In compliance with this policy the commissioners advertised for bids and let the contract for about one-fifth of the complete system. Since then owners within the district have asked that the contract be extended until now the entire system is either under construction or under contract.

Rather than provide a sewage disposal plant for this area, it was found advisable to enter into contract with the city of Lawrence, making it possible to connect the trunk line for the district to one of the trunk lines of the Lawrence sewer system.

Contract Between City and District.—The contract between the city of Lawrence and the district provides: for the payment of $50 for each residence connected to the sewer system; for the payment of a portion of the expense necessary to build or rebuild main sewers in the city of Lawrence, which main sewers under present law, are paid for by the city at large; and for the payment to the city of Lawrence annually a sum equal to the amount which would be raised on all real estate in Douglas County Sewer District No. 1 by a tax equal to the levy made in such year by the city of Lawrence on real estate within the city for maintenance of the sewers of the city.

The contract further provided: that nothing shall be allowed to enter the sewer except such matters as are proper under present ordinances of the city of Lawrence, and any amendments which may be made thereto; that plumbing of any residence within the district shall be installed in conformity with the ordinances of the city of Lawrence relating to plumbing; that all plumbing shall be subject to inspection by the authorities of the city of Lawrence; and that the city of Lawrence may disconnect any residence which may be connected in any way in violation of the contract.

Provisions of Enabling Act.—Provision has been made for the creation of sanitary districts not only by petition from the people within the district, but the board of county commissioners, by resolution, may declare it necessary to build, rebuild or construct, or reconstruct any storm or sanitary sewer, disposal plant, pumping station, or other appurtenances necessary for the proper handling of storm or sanitary sewage, and for which a special tax may be levied. The resolution shall be duly published and if the owners of more than one-half of the property liable for taxation for making such improvements do not within twenty days from the last publication, file protest, the board of county commissioners shall have power to cause such improvements to be made.

The board of county commissioners may create a sanitary district within, or extend any district into, the limits of an incorporated city only upon obtaining the consent of the governing body of such city.

The law further provides, that with the consent of the board of county commissioners, private sewers may be built at the expense of the property owners interested in such improvement, and the board of county commissioners shall have the power to purchase and thereafter maintain sewers so privately built.

Costs Assessed Against Lots.—All costs and expenses involved in creating the district and subsequent construction are assessed against lots and pieces of ground contained within the district in which it is situated (exclusive of improvements), and are levied and placed on the tax roll for collection and collected in the same manner as other taxes. The county commissioners, in its discretion, may provide for payment of the costs thereof by installments, or they may provide for the payment of the entire tax or special assessment at one time.

The board of county commissioners have power to levy a special maintenance tax of not to exceed one dollar on each one hundred dollars of the assessed valuation of the land (exclusive of improvements) within the sewer district or joint sewer districts. The purpose of such fund is solely for creating a maintenance fund to be used for maintaining storm or sanitary sewers, disposal plants, pumping stations, pumps, or other apparatus used in con-

nection with any sewer district or joint sewer district.

The Douglas County Sewer District No. 1 represents the first and only attempt, thus far, to make use of this law in the state; it is, however, not the first attempt in the United States to meet similar problems.

Examples of Sanitation Districts.—The work of the Los Angeles County (California) Sanitation Districts furnishes a notable example of what may be done in solving sewerage and sewage disposal problems by the creation of sanitary districts. In 1926 there were nine County Sanitary Districts in Los Angeles County, covering approximately 432 square miles and including 35 incorporated cities, 35 unincorporated communities, and a comparatively large rural area. The nine county sanitary districts are combined to form the Metropolitan Sewerage System of Los Angeles County, which system has made it possible to treat the entire area involved as a unit in solving the sewerage and sewage disposal problems and treating each district as an integral part. The formation of sanitary districts has been especially desirable in Los Angeles County, not only to cope with the continued and rapid growth in population, but also as a means of conserving the water supply for the entire area.

Another notable example may be cited in the formation of the Sanitary District of Chicago (Illinois). The district includes some sixty municipalities, covering not only Chicago and the Edison Company Territory, but the Public Service Company of Northern Illinois, in part. Some enthusiasts feel that within twenty or thirty years the Sanitary District of Chicago will include all of Cook County. The problem there is primarily one of taking the sewage from the water supply of Chicago and surrounding area, diluting the sewage, then supplementing the dilution by treatment before turning it into the Illinois River.

State laws throughout the United States, with few exceptions, make it possible to form sanitary districts for the collection, treatment and disposal of sewage. It is evident that the development of metropolitan sewer systems must be apart from political boundaries and there must be the fullest cooperation between large cities, small cities, and the developing rural communities. The organization of metropolitan sewer districts is based on the logical grouping of such areas according to their topographic features and common interests. The practice of many municipal authorities at present in solving the immediate demands without thought of the future, will eventually lead to a very ill-advised and uneconomic sanitary scheme, to say nothing of the possible menaces to public health.

Determining Proper Boundaries of District.—A difficult problem presents itself in the determination of the proper boundaries of the sewer district. Provision must be made in correctly designing the sewer facilities for the probable future development of the community. The natural growth of the community will cover land which now may be used only for agricultural purposes, although valued at speculative prices. Such territory, if not included in the sewer district, will obviously be in line for development later and can be sewered only at great expense. On the other hand, to assess an entire township for the construction of sewer facilities which benefit only a very small portion, is clearly unjust. The engineer in establishing the benefit district boundaries must be firm in including such land which is adjacent to and in line for subdivision development and is, therefore, quite obviously benefited by the improvement regardless of the protests from those who may be thinking only in terms of the added return in sale of crops.

From the standpoint of the municipality it is contended by some that the installation of sewers in county sewer districts adjacent to a municipal corporation operates to the disadvantage of the municipality due to the fact that the district provided with sewer facilities and other utilities is not particularly desirous of being annexed to the municipality. This may be true to some extent but, generally speaking, the advantages to a community to be derived by annexation over-balance any possible disadvantages. When a district does comes into the city it represents an asset to it in the way of complete and well designed and constructed sewer systems. Certainly a municipality is fortunate in having the extensions of its sewerage system into the adjacent territory made under capable engineering supervision.

The law providing for the creation of sanitary districts contains the basic elements of a most needed and useful instrument. The refining effects of protests, court actions, experience of use, and legislative amendments, are needed now to make it applicable to all cases that may arise. The legislative amendments that seem apparent at this time would be: first, make provision whereby it would be possible to construct water supply systems in addition to storm and sanitary sewers; and second, since only 22 counties come within the limits set forth in the law, 3 counties exceeding 70,000 and 80 counties falling below 21,000 population (based on 1927 statistics), it would seem that a readjustment should be made in the population limits, possibly the limits eliminated. The act meets a real public need in connection with solving the sanitary problems for unincorporated suburban areas surrounding the larger centers of population, insuring the same regulation by the State Board of Health as applies to incorporated areas.

Acknowledgment.—The foregoing is a paper presented at the meeting of the Kansas Water Works Association.

City Responsible for Damage from Discharging Raw Sewage Into Open Stream

Cities which discharge raw sewage into an open stream and thereby damage farm lands below affected by the polluted waters are responsible to owners of the lands, according to a recent decision of the Indiana Appellate (Supreme) Court, rendered on an appeal of the city of Frankfort against an award in the lower courts to Jay D. Slipher, who brought the original suit for damages. Judgment against the city, in the amount of $3,962.07, was affirmed. Ohio Health News of Feb. 1 comments on the decision as follows:

The decision was a complete affirmation of plaintiff's contention that the city could have remedied the situation, and prevented the damage to his property, by installation of adequate modern sewage treatment works, and that the city, under the law, was responsible for damages caused by its failure in this regard. Sections of the decision of particular interest are as follows:

The contention that appellee could have obtained relief under Sec. 8125 et seq. cannot prevail. These sections simply provide a method by which the common council, the board of health of any city or town, the board of commissioners of any county, the trustee of any township, or 10 per cent of the electors of any city, town or village may file a complaint with the state board of health charging the pollution of the source of any public water supply, or that the water of any stream, spring, lake or pond is being polluted, thereby materially injuring, for domestic use, the character of the water into which the same is discharged to the injury of the public health or comfort. As shown by the title of the act of which the above sections are a part, the statute gives the state board authority to enforce the provisions of the act for the protection of the public health. The statute is not available to an individual landowner like the appellee, who suffers a special injury different from that suffered by the public. The individual landowner must seek relief through the courts, as did the appellee in the instant case.

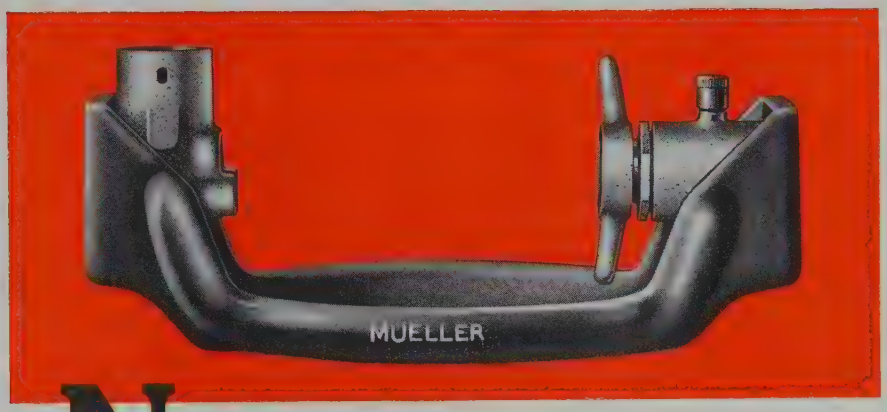
The first and second contentions of appellant will be considered together.

Appellant argues that since it is by statute authorized to build and maintain an adequate system of sewers for the disposal of its sewage, it may lawfully discharge its sewage without purification into a stream which is the natural outlet, and that so long as such discharge is without negligence it is not liable to a person through whose land the stream flows, though the water of such stream is polluted and the rental value of such land is diminished thereby.

The court, after referring to a number of Supreme and Appellate court decisions bearing upon the issue, said:

The rule of necessity thus declared must in and of itself inevitably force just the opposite doctrine, in the interest of the public health, the very thing supposed to be subserved by the rule, when it is daily becoming more and more apparent that the sewage in the streams is a real menace to the public health, and it is not a necessity, because it can be otherwise provided for, with practicability and assured safety to the public health.

* * * Under the facts as found by the court, public necessity did not call for or require the pollution of the water of either Prairie Creek or South Fork, and since appellant, by the expenditure of a reasonable sum of money, could have adopted a method of purifying the sewage, the judgment should be affirmed.



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Operating Experiences With Large Capacity Filter Plant

Data on Purification Works of Essex Borders Utilities Commission

By J. CLARK KEITH
Chief Engineer, Essex Border Utilities Commission, Windsor, Ont.

THE operation of any filtration plant, large or small, usually gives rise to problems which are peculiar to that plant alone. Plant operation may be largely a matter of routine procedure, but there must be constant vigilance to detect the unusual condition when it does appear.

The purification plant operated by the Essex Border Utilities Commission has a nominal capacity of 21 million Imperial gallons per day. In one respect at least it is unusual, in that it is jointly owned by nine communities serving approximately 120,000 people. The capital costs were originally apportioned on the estimated consumption of each municipality five years hence. The operating costs are based on the actual amount of water delivered to each municipality. This is determined by meter measurement. The plant delivers water by gravity to two pumping stations, one privately owned by the Walkerville Water Co., which serves four communities, the other the municipal plant of Windsor, which serves the other five.

The Supply.—The source of supply is in the Detroit River and is a typical Great Lakes water. The initial source of possible trouble in any plant is naturally at the intake. Due to the constant movement of ferries between the Canadian and American shores, there is seldom an ice cover over the intake which is located in 40 feet of water about 1½ miles upstream from the ferry crossing. Under favorable conditions frazil ice develops which has adhered to the 8 ft. bell mouth of the intake, causing partial or complete interruption of flow.

In designing the low lift pumping station, the possibility of such trouble was recognized, as it has occurred in other intakes along the Detroit River. The piping from the pumps was so arranged that pressure could be applied to the intake in the belief that the ice which had formed at the mouth could be blown off. Frazil ice has appeared in this intake on three separate occasions in such quantities as to cause almost complete interruption of service. In each instance, immediate relief has been secured by reversing the flow in the intake. Large masses of ice conforming to the contour of the pipe would then come into the suction well. The average time required for the operation is 25 minutes, during which period the reservoir is being drawn upon.

Frazil ice did not appear during the past winter, though conditions, based on previous experience, were favorable for its formation. Continued cold, not common to this district, caused Lake St. Clair and the upper part of the Detroit River to freeze over and to remain covered with ice. This ice cover prevented the formation of frazil ice in that section of the river from which this supply is drawn.

The water entering the suction wells is comparatively free from the larger debris such as tree limbs, submerged logs, leaves and weeds and no great amount of these is removed by the revolving screens. Late in the autumn fairly heavy quantities of weeds find their way into the suction well. These are believed to be set free by the impellers of passing freighters. It is found that a half revolution per 8 hour shift is sufficient to keep them clean.

Application on Coagulants. — The coagulants, fed from dry feed machines, are applied to the water at the entry to the suction wells and are mixed by the turbulent action of the water in the wells, the passage through the low lift pumps and in the "over and under" type mixing chambers at the entrances to the coagulation basins. Sulphate of alumina is the principal coagulant and the dosage is determined by the quantity and quality of the turbidity in the raw waters. The dosages applied generally range from a minimum of 0.6 G. P. G. to a maximum of 3.5 G. P. D., with an average dosage of 0.89 G. P. G.

During the month of April, 1929, turbidities as high as 800 P. P. M. were recorded. The average for the month was 175 P. P. M., which is the highest monthly average noted since the opening of the plant three years ago. To reduce these turbidities to a maximum of 40 P. P. M. in the applied water and to maintain an effluent of less than 1.0 P. P. M. alum dosages from 20 per cent to 80 per cent in excess of the scheduled dosages were applied. During one 24 hour period it was necessary to apply 5 G. P. G. to a raw turbidity of 275 P. P. M. to produce a satisfactory effluent.

These unusual turbidities are believed to arise from the high water now prevailing in Lake St. Clair. Silt and sand have been accumulating on the shores for years and these have been brought into suspension by the change in lake levels. Lake St. Clair is, relatively speaking, so shallow that even a moderate wind disturbs the entire lake body.

Dosage with Iron and Lime.—Ferrous sulphate and hydrated lime were introduced as coagulants in May, 1928, in an effort to increase the length of filter runs during the "algae" period. During the month of June, 1927, it became necessary to backwash filters every 1½ hours as a result of the high plankton content of the raw water. This affected the quality of the effluent and the delivering capacity of the plant to such an extent that a remedy was sought to better plant operation during that period.

Dosages ranging from 2.4 to 2.0 G. P. G. iron and 1.8 to 1.0 G. P. G. lime were fed and satisfactory results were obtained in all cases. The maximum dosage represented a cost 2.75 times that of the scheduled alum dosage while the minimum dosage cost 1.6 times as much. The lime and iron were fed separately from two dry feed machines ordinarily used for lime. We learned by experience that they could not be fed from the same machine as in combination they formed sulphate of iron within the hopper. It was necessary to add small paddle wheels to the machine delivering lime to prevent arching over. Sulphate of alumina cost $26.20, hydrated lime $14.00 and sulphate of iron $21.00 per ton, all delivered at the plant.

Conclusions Regarding Use of Lime and Iron.—During the period when lime and iron were employed as coagulants, the following conclusions were reached or results attained:

(a) The service hours of the filters were extended to a minimum of 10 hours.

(b) The effluent did not suffer, physically, at all times having less than 0.5 parts of turbidity.

(c) The filter mat showed less signs of shrinkage and cracking than was observed during the "algae" period of 1927.

(d) Lime and iron required approximately 15 per cent more wash water per M.G. filtered than was required with alum as the coagulant when length of run and turbidities were equal.

(e) An increase in the turbidity of the raw water above 25 P.P.M. could

be met with a decrease in the quantities of coagulants used.

(f) The results obtained justified the added cost and the use of lime and iron in the "algae" period will be continued.

The period of retention in the coagulation basins ranges from 1½ to 4 hours, depending upon the demand. The basins are cleaned twice yearly, following the spring algae period and again in the late autumn. Normal procedure permits the draining, cleaning and refilling of a single basin in ten hours.

Mudball.—Mudballs appeared shortly after the opening of the plant. On examination it was found that a large portion of them had formed with a cotton seed as the nucleus. This seed had apparently been in the car in which the filter sand was loaded. Others were flat or almond shaped. The former was found to a depth of 20 in. in the sand, while the latter remained on the top of the bed. They were removed by fishing the beds with wire mesh scoops while wash water was applied at a rate just sufficient to expand the sand. Their appearance was not noted again, to any extent, until November, 1928, when, following a period of slimy turbidity, they were found in all beds. Extra backwashing and fishing with the wire mesh scoops kept them under control and they disappeared early in December. These formations have never been larger than a good sized bean and have been in evidence only twice in three years.

The Sand.—Some shrinkage from the side and end walls has been observed. The average width of the crack is ⅜ in. and it reached a depth of 2 to 3 in. During the spring algae periods, this shrinkage increases and a maximum width of ¾ in. with a depth of 6 in. has been observed. A physical examination of the sand in every bed was made in November, 1928. Samples were taken at four depths and the coating on the sand grains was determined from their specific gravity. The curve used in these determinations was developed at the Detroit filtration plant where the S.G. of the dry coating was found to be 2.0. The S.G. of the dry clean sand is 2.65.

A storage capacity of 2.3 m.g. is afforded in the clear well and reservoir. This represents a supply sufficient to meet the demands of these communities for a maximum period of 7 hours and a minimum, assuming a demand at a rate of 20 M.G.D., of 2 hours and 50 minutes. The reservoir is 11 ft. deep and the minimum working level permitted is 9 ft. 6 in. The average depth maintained is 10 ft. 3 in.

Raw turbidities have ranged from a minimum of 5 P.P.M. to a maximum of 800 P.P.M. The maximum monthly average in 1928, was 125 P.P.M. and the average for the year was 30 P.P.M. The filtered water is checked for turbidity at least six times daily, using a Baylis Turbidimeter. A maximum of 1.0 P.P.M. was present for a few days in 1928 in the effluent, while the average recorded was 0.3 P.P.M.

Rate of Flow.—The rate of flow through the filter beds is governed by three factors: the demand being made upon the plant, the filtering efficiency of the beds and the filter maintenance programme. A filter rate is maintained which will bring all beds into service during the peak hours of the day. Rates are not changed daily. The rates employed in 1928, expressed in terms of Millions of Imperial Gallons per acre per day, ranged from a minimum of 99.6 to a maximum of 118.5, with an average throughout the year of 112.07.

Laboratory control is exercised over all operations in the plant. The raw and applied water are examined for turbidity every 2 hours and the alum dosage changed as required.

Laboratory Control.—Samples of raw and filtered water are collected 5 times daily for bacteriological analysis and colony counts are recorded which develop on agar plates at 37°C. in 24 hours. The average raw water developed 39 colonies per 1 cc. and the filtered water 6 colonies per 1 cc., showing a removal of 85 per cent B. Coli—aerogenes isolations are made following "Standard Method" procedure, using Lactose broth fermentation tubes and Eosine Methylene Agar for confirmation. The results are expressed in term of "Most probable number per 100 cc." The maximum B. Coli content of the raw water has occurred in April when 117.4 colonies per 100 cc. were found. A minimum of 4.99 was recorded in June, while the average for 1928 was 50.44. The average number found in the filtered water was 1.59, with a maximum of 2.39 and a minimum of 0.98, with an average removal of 96.8 per cent.

Air and water temperatures are recorded every 2 hours and the wind direction is noted at these times. It is known that the velocity and direction of the wind have a definite bearing on raw water turbidities during the spring, summer and autumn seasons. It is thus possible to anticipate plant conditions some hours in advance.

Early in 1929 daily examinations of the raw water were begun to determine plankton content. It is expected that a relationship between these findings and the service hours of the filters will be ascertained when sufficient records are available for study. This will provide additional means of determining coagulant dosages. In the three months period in which these examinations have been made, no members of the plankton families, not common in the Great Lakes water, have been identified. Microcystis (Cyanophyciae) appear frequently and represent from 20 per cent to 50 per cent of the total daily counts.

Records.—Daily records are kept of every operation carried on in the various departments of the filtration plant. In the low lift pumping station the rate at which the raw water is being pumped to the coagulation basins and the total gallons pumped are recorded each hour. The total gallons of wash water delivered to the filter beds are also recorded. The power used by the various pumping units and the total power consumption of the plant is recorded once daily. The total hours in service of every unit in the pumping station are logged on the daily report form.

In the filter building all meters, loss of head and rate of flow gauges are read and recorded every hour. The depth of water in the filtered water reservoir is recorded hourly. These daily records are summarized each month and they in turn are built into an annual report. A plant diary provides a permanent record of items of ordinary or unusual interest and constitute a permanent plant history. All gauges and indicating or recording devices are kept in working order at all times and the utmost care is taken to ensure knowledge, if not control, of every operation attempted. One employee is constantly engaged on plant maintenance and it is rarely necessary to place any unit out of service except for inspection or maintenance.

The plant is electrically operated with power supplied by the Hydro Electric Power Commission of Ontario. The rates are $1.00 per H.P. per month based on the peak load, 2¼ ct. per K.W. for the first 50 hours 1½ ct. for the second 50 hours and .33 ct. for all additional power.

Operating Cost.—Operating costs, divided into five major divisions, i.e. salaries, power, overhead, coagulants and maintenance, totalled $12.58 per M.G. filtered.

The average cost of coagulants per M.G. was $2.09, which included the added cost of "Lime and Iron" coagulation. During the period when "Lime and Iron" coagulation was employed, the average cost per M.G. was $4.09. Alum coagulation during the balance of the year represented an average charge of $1.71 per M.G. filtered.

Salaries represented $4.28 of this sum, Power $2.74, Overhead $2.33, coagulants $2.09 and maintenance $1.24.

The operating staff includes a superintendent, a chief operating engineer, a chief filter operator, three operating engineers, two filter operators and a utility man. The lowest wage paid is 62½ ct. per hour.

The total power consumption for 1928 was 1,455,000 K.W. Hrs., costing an average of 0.82 ct. per K.W. Hr. The pumping cost for power alone, exclusive of wash water, average $2.55 per M.G. or 6.7 ct. to raise 1 M.G. 1 ft.

Overhead charged include supervision, rentals paid for use of railway right-of-way, taxes and insurance. A depreciation reserve of $3,000 is set aside annually to replace the heating system, motors and pumps which will

need replacement within the 30 year life of the debentures.

Maintenance charges include the general upkeep of machinery, buildings and grounds and the purchase of miscellaneous supplies required in this work. The grounds are attractively maintained as water works plants should be. Acknowledgment is made to G. H. Strickland, plant superintendent, for much of the information contained in this paper.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th Annual Convention of the American Water Works Association.

Fibrated Asphalt Planking Waterproofing Floor Construction on LaSalle St. Bridge, Chicago

Of late years a great deal of attention has been directed by engineers to some vital requirements in the construction of floors and of the waterproofing course, on both fixed and movable bridges and on the approaches to such structures.

In the specification of materials entering into the construction of the La Salle St. bridge, Chicago, and the approaches to it, considerable attention was devoted on the part of engineers to the requirements of this particular structure—first, as relating to the waterproofing, and second, relating to the wearing surface on the bridge itself.

The illustration, Fig. 1, is of the north approach to the bridge, and the picture shows a crew installing the fibrated bituminous waterproofing planks of the Servicised Products Corporation, Chicago, directly over the waterproofing fabric itself. On the deck pictured, 14,000 sq. ft. of fibrated asphalt sheets, 24x36 in., were laid as a protection to the waterproofing. The waterproofing fabric was laid over the concrete, and while the asphalt was still in a plastic condition, the waterproofing fibrated asphalt planks were placed in position. The granite block paving for the bridge approach was laid immediately over the waterproofing protection course.

The preformed fibrated bituminous sheets provide a blanket of tough, resilient material over the waterproofing, which reinforces the waterproofing itself by increasing its thickness or body, and so protects it from direct damage. It is claimed that due to the fibrous nature, toughness, high tensile strength and the inherent waterproofing qualities of the protection course, the integrity of the waterproofing is maintained indefinitely, regardless of shock and vibration from traffic, the condition of the weather or the state of the temperature.

Its use prevents leaks through the structure, as the greater the pressure upon it, the tighter the waterproofing becomes. The material is sufficiently strong and tough so that it bears the usual loads without distortion.

The very quality of resiliency and toughness enables it to give and take the movements of the main structure. Such a waterproofing course has also some of the qualities of an expansion joint in that it is unaffected by extremes of temperature.

Figure 2 shows Servicised fibrated asphalt plank being installed on the south leaf of the La Salle St. bridge.

The outstanding feature of fibrated asphalt planking is its adaptability to any particular surfacing requirement. The composition of the material can be varied to meet the practical necessities in each case. Fibrated bridge flooring material is constructed of asphalt saturated felt and asbestos fibre for binding, and of asphalts thoroughly mixed with fine mineral matter for compressive strength, and for increasing the abrasive and wearing qualities.

To increase the tensile strength, mats of irregularly overlapping fibre are introduced and further resiliency is effected by inserting divided fibre between the spaces or mats of the linear fibre.

Fig. 2—Servicised Fibrated Asphalt Planking Being Installed on the South Lift of the La Salle St. Bridge, Chicago

When the material is finally incorporated by pressure, into a block-like structure, it is then a composition of extreme toughness, highly resistent to wear and at the same time, extremely resilient and accommodating itself easily to the expansion and contraction movements of the bridge structure.

It is easily laid, in fact just as easily handled as wood planking. There is no difficulty in using the material any time of the year in any climate and without especially trained labor.

Streets and Sidewalks at Boston, Mass.—Boston has a total of 626 miles of roads. The total area of the streets is 11,919,844 sq. yd. The average width of street is 48 ft., the average width of roadway 32 ft., sidewalks 8 ft., residential streets 40 ft., residential roadways 26 ft., and sidewalks 7 ft. The width of boulevards varies from 100 ft. to 200 ft., with roadway width from 25 ft. to 43 ft. The sidewalk widths range from 12½ ft. to 25 ft. The park strips range from 25 ft. to 100 ft. The width of thoroughfares is from 60 ft. to 122 ft., with a roadway from 40 ft. to 92 ft. Sidewalks range in width from 8 ft. to 20 ft.

Fig. 1—Servicised Waterproofing Slabs Being Installed on the North Approach to the New La Salle St. Link Bridge, Chicago. Approximately 14,000 Sq. Ft. of 24x36 In. Fibrated Bituminous Planks Were Used, and the Granite Block Pavement Laid Immediately on This Cushion

Electrically Welded Pipe Line for Springfield, Massachusetts

Process Employed in Fabricating Proven Mountain Line

By S. MARTIN, JR.
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THE pipe for the Springfield water line was made in 30 ft. lengths from two 30 ft. plates which were bent into half circles and automatically arc welded together. Some consideration was given to welding of the girth joints in the field, but because of considerable opposition, it was decided not to do this on this particular job, and the 30 ft. sections were riveted together in the field. To provide for this, the plates were sheared so that the pipe diameter increased slightly from one end to the other, thereby permitting the small end of one section to fit into the large end of the next section an amount required for the riveted joint.

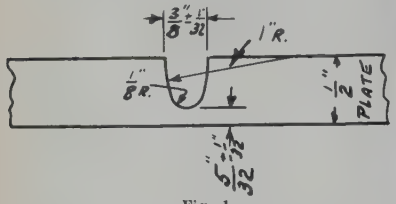


Fig. 1

The first operation in the manufacture of the pipe after the flat plates had been sheared to size was to bevel the sides accurately as shown on Fig. 1. This is done simultaneously on two plates on the plate planer, as shown in Fig. 3. On each plate two lines were then scribed, parallel to the upper edge of the bevel and ¾ in. from it.

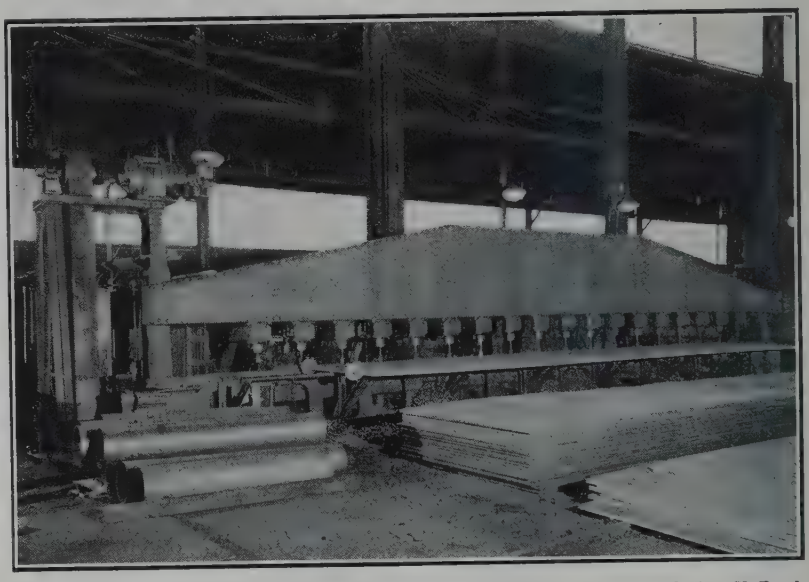


Fig. 3—36-Ft. Planer with Two 30-Ft. Pipe Plates Clamped in Position for Planing U Bevel Preparatory to Rolling and Welding

The plate was then taken to the bending rolls, and by means of a special jig, the 30 ft. edges were bent to the proper radius. The whole section was then formed into a true half circle. Next the two halves of the pipe were placed in a specially designed frame, Fig. 5, and tack welded together approximately every 16 in. on the inside, by hand. The pipe section was then removed and a complete bead run inside by hand. It is then ready to be placed in the welding machine as shown in Fig. 6.

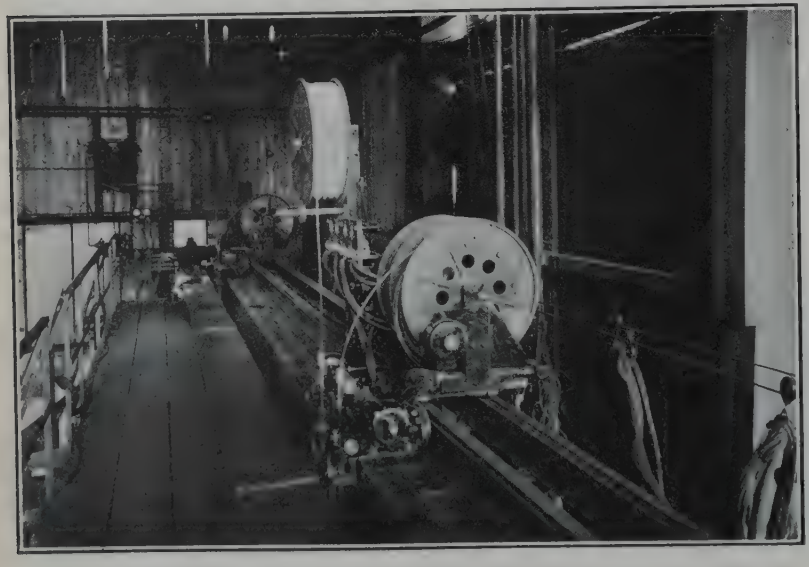


Fig. 2—Two Multiple Arc Welders with Travel Carriages Mounted on 36-Ft. Pipe Welding Machine

Pipe Welding Machine.—The pipe welding machine consisted essentially of three horizontal beams, two above and one below. Enclosed in the lower beam and extending throughout its full length were several sections of fire hose to which compressed air was admitted. On the hose rested a series of plungers, which is turn supported a "backing bar," the latter being fitted with a flat copper chill bar approximately 2 in. wide. Application of compressed air caused the hose to expand, thereby raising the plungers and the copper strip in the backing bar was pushed up against the under side of the joint at a pressure of 200 lb. or more per running inch. The backing bar was also provided with an insulated conductor which formed part of the return circuit for the welding current. By shunting the proper cur-

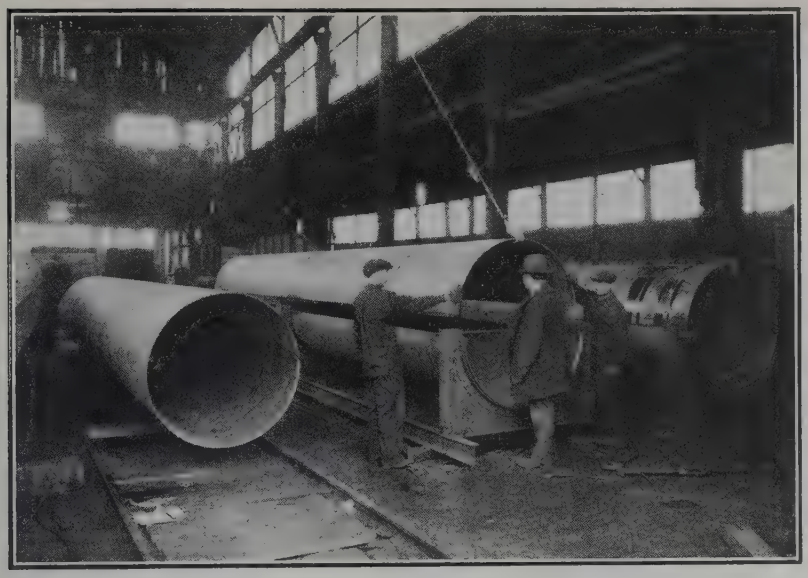


Fig 5—Assembling by Tack Welding Two Halves of a 30-Ft. by 48-In. Diameter Pipe Before Going to Automatic Welder

rent through this bar when the pipe was being welded, the magnetic disturbances of the arc were very effectively controlled.

To the lower side of the upper beams of the machine were attached two copper jaws spaced approximately 2 in. apart and the pipe was placed in the machine so that the joint to be welded was located centrally between these two copper jaws and directly over the copper strip in the backing bar.

Figure 2 shows the double head automatic travel carriage for the welding after the plates have been properly clamped in the welding machine. Two such carriages were mounted on the 30-ft. machine. This meant that each one of these did 15 ft. of pipe and reduced the welding time to 50 per cent of that required for one carriage. A third such double head travel carriage is being contemplated for a further saving of welding time on future operations.

After one seam was welded, the pneumatic clamp was released and the pipe rotated to bring the second joint in position.

Speed of Welding—Electrode-Power Consumption.—The speed of welding attained by the multiple arc process with two welding heads on ½-in. plate was approximately 28 ft. per hour. Using the welding conditions formerly outlined, about 1 lb. of electrode was deposited. The current for each pair of welding heads was supplied from a 1,000 ampere-1 hour rated constant potential welding generator driven by an induction motor. The power consumed was approximately 2.15 kw.-hr. per foot of weld on ½-in. thick plate.

Testing.—At the request of the inspector, check test plates about 12 in. long and a total width of 16 in., with a bevel as specified for the pipe joints, were placed at each end of the pipe seam and welded under the same conditions as the pipe itself. These plates were then cut into specimens. Some of these were tested in tension, others bent and still others were put in a fatigue testing machine.

The pipe itself was given a thorough visual inspection to determine possibility of holes, lack of fusion and reinforcement. The weld was reinforced—i. e., its height above the surface of the plate was usually from 1/16 to ⅛ in. The minimum and maximum values permitted by good practice are 1/32 and 3/16 in. respectively. The weld bead must also be central between the scribed lines on the plate at each end of the joint, allowing a maximum variation of 1/16 in. from the center. The width of the weld bead was measured and its over-all width was not permitted to be less than 9/16 in. Any holes which were seen on the top surface of the deposited metal were carefully chipped and if they extended below the surface of the plate, the spot was rewelded by hand. The edges of the bead were also examined to see that the weld metal was thoroughly fused along the top of the plate. Any cracks or hollow spots were chipped and rewelded by hand.

After the welded pipe had been given a careful visual inspection and any defects rewelded, it was placed in the testing machine, Fig. 7, and subjected to the following hydro-static pressures in pounds per square inch:

Thickness of Pipe in In.	5/16	⅜	7/16	½
66-in. pipe	....	160	....	....
54-in. pipe	135	160	187	213
48-in. pipe	....	....	210	240
36-in. pipe	....	....	....	320

In this particular installation the rivet holes were then punched in each end of the pipe, after which it was thoroughly cleaned and dipped vertically in an electrically heated tank of coal tar pitch varnish (Fig. 8). The pipe was submerged in the bath long

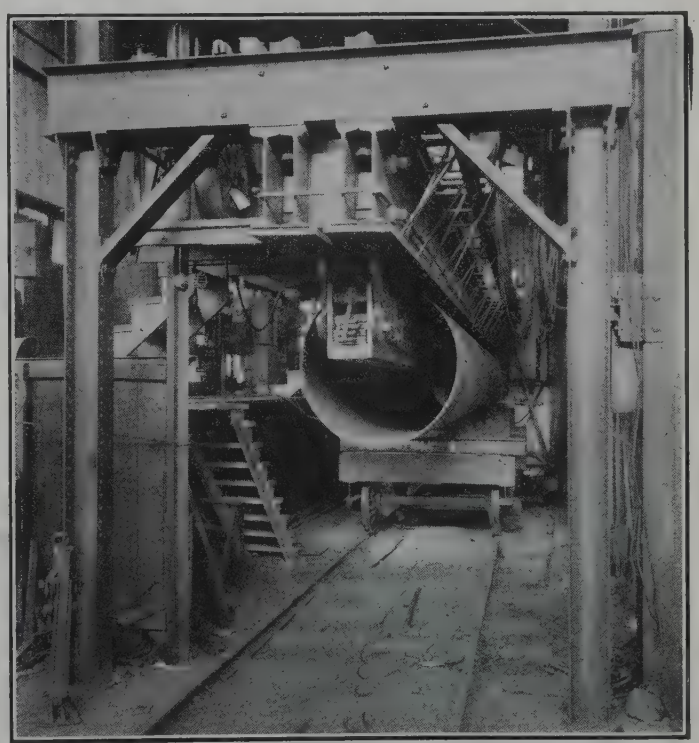


Fig. 6—Loading End of 36-Ft. Pipe Welding Machine Shows Lower Supporting and Pneumatically Operated Backing Up Beam Locked in Position for Welding

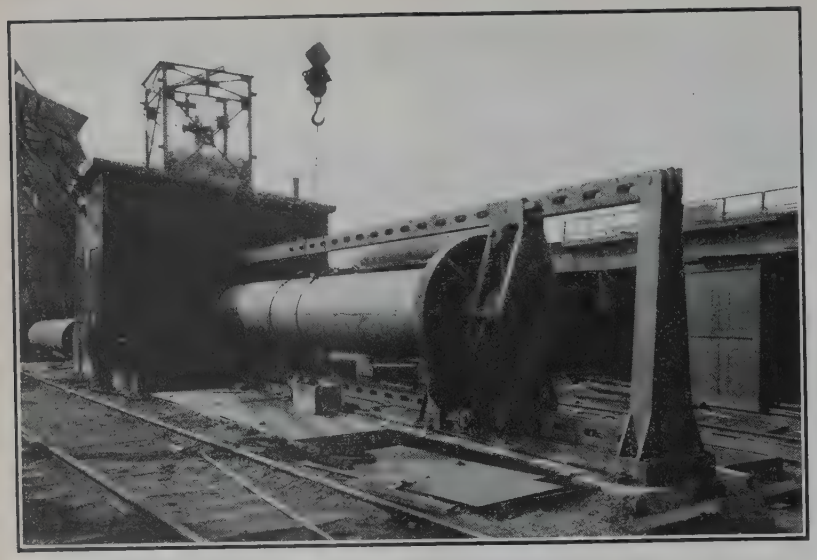


Fig. 7—Hydraulic Testing Machine with 30-Ft. Long, 48-In. Diameter Pipe in Place

enough to heat the metal uniformly to the temperature of the bath. It was then removed and suspended in a vertical position until the coating had drained and set.

Acknowledgment.—The above is abstracted from a paper presented at the 49th annual convention of the American Water Works Association.

Water Rates

In the sale of any commodity, and water is a commodity, there must be in all fairness some basic principle upon which its cost of production and sale can be established, so that each individual may receive equitable results. In other words, the cost of service is made the legal basis for rates. To determine upon a rate which is fair and equitable, both to the consumer and to the water department, demands a consideration of all the factors which enter into the operation of the plant. These may be designated and grouped to meet requirements of the individual plant and existing conditions. The practice of determining rates by comparison with other cities is a false standard.

Water rates should be based upon the cost of production. A very important element is the value of the property that is rendering service. In order to render good service, the utility must be financially sound. It has been my observation that financially poor utilities and poor service go hand in hand. The rate charged must be sufficient to meet all fixed charges, otherwise the utility cannot function on a sound financial basis. Our rates are just, fair and reasonable, and are based upon the cost of the finished product, without regard in any way whatever to the rates in vogue in any other city, whether higher or lower.—Extract from 1928 annual report of W. H. Lawrence, Superintendent of Water Works, Kalispel, Mont.

Fig. 8—Lowering a 30-Ft. by 48-In. Automatically Arc Welded Pipe Into an Electrically Heated Vertical Tank of Coal Tar Pitch Varnish to Give Pipe a Protective Coating

Municipal Garbage Removal Governmental Function

The Supreme Court of Appeals of Virginia, in a decision rendered March 21, 1929, in the case of Asbury v. City of Norfolk (147 S. E. 223), held that garbage removal by the city was a governmental function. The decision is reported as follows in Public Health Reports May 31, 1929:

An action was brought against the city of Norfolk because of personal injury to plaintiff caused by being struck by a runaway horse which had been hitched to a wagon being used at the time in the removal of garbage. The question which was before the Supreme Court of Appeals was whether, in the removal of garbage, the city was acting in a governmental capacity and was thus relieved from liability for negligence. The holding was that garbage removal by a city was a public governmental function, as contrasted with a corporate or private function, and that the city was not liable. In deciding the matter the court said that "There is some conflict in the cases, but the weight of authority quite certainly is to the effect that the removal of garbage by a municipality is a governmental function, which is designed primarily to promote public health and comfort, and hence that the municipality is not liable therefore in tort when the negligence which is charged occurred in the performance of that particular function, and no nuisance is thereby created."

Financing the Operation and Maintenance of Sewage Treatment Plants

How This Important Problem Is Handled in Various States

By EARNEST BOYCE
Chief Engineer, Kansas State Board of Health, Lawrence, Kan.

THOSE interested in the problem of adequate sewage disposal are constantly confronted with the fact that sewage disposal plants built to accomplish the destruction of the objectionable characteristics of sewage wastes are, after being built, frequently not operated so as to obtain the results expected. While many plants are given good supervision, in at least the average plant the operation must be considered as being the minimum attention that the city can give and yet avoid damage claims due to faulty operation. Governing bodies are usually willing to provide adequate funds for city departments when the expenditure is demanded and expected by the taxpayer of the city, but it is hard with the many demands made on a city's financial resources for a governing body to provide funds to dispose of sewage wastes after they are conveyed to a point where they will not annoy the residents of the city.

The demand for the installation of sewage treatment works and later for their efficient operation comes in most cases not so much from a sense of civic responsibility as from demands by damaged property owners with threatened suits or from some state supervisory authority—usually the State Department of Health. Consequently, a city is quite apt to adopt, or rather lapse into a policy of doing only that which is definitely required. A sewage disposal plan may be considered as manufacturing a product of little or no value out of a waste material which, before this process existed, was a definite liability. No revenues are produced that in any way equal the expense, consequently the cost of the plant and its operation must be paid out of benefits that accrue from the removal of the liability represented by the untreated sewage waste.

The most common place to carry the cost of sewage treatment is to include it in the general tax levy. There is some reason to consider this as a just and proper place for the charge. But funds must be available and the proper appropriations secured in competition with many other demands.

Sewer Service Charge.—If we consider that a system of sewerage exists only to give service to those contributing sewage wastes, then we should properly classify this municipal improvement with other public utilities and expect that all charges for capital and operating costs be paid by those who are served. This view has been reflected in recent legislation in several states where provision is made by statute for the charging of sewer rentals. There are some who feel that a sewer is not properly a public utility but rather a necessity from the standpoint of public health and being necessary to the health and well-being of the community should be paid for by the community as a whole. When an individual makes use of a public utility, such as telephone, electricity, gas, or water, he is primarily interested in the service given by such a utility. A person not interested in having this service is at liberty to do without it. While it may inconvenience others, his unwillingness to have the utility does not create any hazard for his neighbors. With the sewer, it is different. It is important that all and not a part of the sewage wastes be removed from the city. The poorest as well as the most expensive property should be given service,—in fact, not infrequently it is necessary to require in the interest of better sanitation that sewer connections be made against the property owner's will. Such procedure would be unheard of with any other utility. It is more nearly comparable with fire protection service. This comparison might be carried further. We divide our public water supply costs and charge fire protection costs to general taxation and the costs of water supply service to the consumer, in proportion to the use he makes of this utility. It would seem that the principle that has been followed in the past of paying for sewers and sewage disposal improvements by general tax levy is a sound one, but it may be that after the community has, as a whole, provided this service, it is proper that those who use the sewers should pay for their maintenance and operation, and possibly in approximate proportion to the amount of such use.

The cost of sewage treatment was formerly principally one of first cost with a very small item, proportionally, of maintenance. At present, where modern sewage disposal is provided or where all or a part of the sewage must be pumped, there is an annual charge that must in some way be carried in the budget of the city. The service has undoubtedly gone beyond where all the expense should be considered as incurred in the interest of sanitation alone.

If charges are made against the use of the service rendered by a system of sewerage, there remains the problem of deciding how these charges should be apportioned. It has been suggested that since sewers primarily serve the purpose of removing the city water after it has been used, the amount of water used is a measure of the use made of the sewer and might give a rational basis for rental or service charges.

How the Ohio Rental Law Works.—The subject of sewer service charges as a means of financing sewerage and sewage treatment was given consideration by a committee on sewage treatment at the Conference of State Sanitary Engineers. It was considered as one of the three main items to be considered in 1928 by the committee, the other two being, first, a study of progress in establishing technical operation of treatment works and, second, continued sewage treatment research. The operation of the Ohio sewer rental law enacted in 1923 was discussed in detail in their report as follows:

"It is well to review briefly the sewer rental situation in Ohio. Seventeen municipalities are now financing their sewerage and sewage treatment works either in whole or in part out of moneys collected from sewer rentals. The smallest municipality in this list has a population of less than 600 and the largest over 150,000. The charges average about $4 per sewer connection per year, although they vary from $1 to $8 annually. Payment is usually made upon the quarterly plan. The manner in which the charges are made vary. The number of municipalities basing the charges upon the volume of water consumed (5) about equals the number making a flat rate single charge per sewer connection (4). A flat rate according to the number of fixtures is employed by two; and two others have a flat rate schedule per connection according to the character of the premises served. Variations in amounts of charges are on account of the variations in size of the municipalities, and the differences in amounts of funds attempting to be secured. For example, the $4 annual charge at Delaware (8,576) is planned to meet expenses of maintenance, operation, etc., but not to meet sinking fund charges on the new plant. In order to include a substan-

tial portion of the sinking fund or replacement charges, the small city of Kenmore (12,683) charges $8.

"There seems to be a well defined trend in Ohio and elsewhere to adopt the rental or utility idea of financing sewerage works maintenance and operation. Experience indicates that such a plan is most favorably considered and is easy to place in operation wherever a new sewage treatment works is being installed or a complete renovation being given to an old treatment plant."

From other references, we find that the estimated revenue from sewer rentals at Delaware, O., will amount to $11,000 per year. It is estimated that this will be sufficient to maintain and operate the treatment works, and the sewerage system as well. It will also carry the clerical cost necessary for collection. Sewage pumping is necessary and the sewage is treated by passing it through an Imhoff tank and sprinkling filters.

The North Carolina Law.—The Sessions Laws of North Carolina for 1927 provide for the creation and maintenance of sanitary districts. Section 20 of that law is interesting in that it covers service charges and rates in the following words:

"A sanitary district board shall immediately upon the placing into service of any of its works apply service charges and rates which shall, as nearly as practicable, be based upon the exact benefits derived. Such service charges and rates shall be sufficient to provide funds for the proper maintenance, adequate depreciation, and operation of the work of the district. Any surplus from operating revenues shall be set aside as a separate fund to be applied to the payment of interest on bonds, to the retirement of bonds, or both. As the necessity arises the sanitary district board may modify and adjust such service charges and rates from time to time."

The Michigan Law.—Michigan statutes provide that a city may, by charter, acquire, establish, operate, extend and maintain sewage disposal plants, sewers and plants, either within or without the corporate limits of the city, as a utility, including the fixing and collecting of charges for service covering the cost of such service, the proceeds whereof shall be exclusively used for the purpose of city sewage disposal system to include a return on the fair value of the property devoted to such service, excluding from such valuations such portions of the system as may have been paid for by special assessments.

In act 320, Michigan Statutes 1927, a portion of Section 2 reads as follows:

"Such sewage disposal plant and system shall be considered a public utility within the meaning of any constitutional or statutory provision of this state for the purpose of purchasing, owning, operating, constructing and equipping such sewage disposal plant and system."

Section 2 further provides that a municipality may issue bonds beyond the general limits of the bonded indebtedness providing such bonds shall not impose any general liability upon the municipality but shall be secured by revenues from the operation of the system of sewerage. It likewise provides that the system of sewerage may be taken over and operated under a franchise as a security provision for bonds.

Section 3 provides:

"The legislative body may establish just and equitable rates or charges to be paid to it for the use of such sewage disposal plant and system by each person, firm or corporation whose premises are served thereby."

The Provision in Pennsylvania.—In the 1927 Session Laws of Pennsylvania, Section 2170 to 2173, inclusive, the following provision is made for the assessment of cost of maintenance and repair:

"Whenever any borough has constructed any sewer or sewer system, or has acquired wholly or partially the same at public expense, the council of such borough may provide, by ordinance, for the collection of an annual rental or charge, for the use of such sewer or sewer system, from the owner of property served by it. The council may, at its discretion, in lieu of such annual rental or charge, provide for the payment by such owner of a fixed sum.

"Such annual rental shall not exceed the amount expended annually by the borough in the maintenance, repair, alteration, inspection, depreciation, or other expense, in relation to such sewer or sewer system, and may include any interest on money expended by the borough in the construction of the sewer or sewer system. The said annual or fixed sum shall be apportioned equitably among the several properties served by the said sewers.

"Such annual rental or charge, or such fixed sum, shall be authorized and collected as provided by general ordinances, and, when so levied and charged, shall be a lien on the properties charged. The collection thereof shall be made and enforced in the manner municipal claims are now or may hereafter be collected.

"The councils of such borough shall execute a warrant or warrants, authorizing the collection of such annual sewer rentals or charges, or such fixed sum, to the officer employed by council to collect the same. Such officer shall have the authority now vested by law for the collection of borough taxes.

"Such annual sewer rentals or charges, or such fixed sum, shall be a lien on the properties charged with the payment thereof, from the date set forth in the ordinance, and, if not paid after thirty days' notice, may be collected by an action of assumpsit, in the name of the borough against the owner of the property charged, or by distress of personal property on the premises, or by a lien filed in the nature of a municipal lien."

The Kansas Law.—A statute may provide that special levies may be made for maintenance and operation. For example, the Kansas law in Section 12-630, Revised Statutes of 1923, provides as follows:

"Levies for sewage disposal plants. That all cities of less than 50,000 in the state of Kansas be and are hereby authorized to levy a tax, in addition to all other taxes allowed by law, not exceeding one-half mill on the dollar upon all taxable property in such cities, to be collected as other taxes and used for the purpose of maintaining and operating sewage disposal plants. Such levy shall not prevent the use of other funds available for the same purpose."

We believe that in the future more thought will be given to the matter of providing adequate operating revenues and that some sort of service charge will be more generally adopted as being an equitable method of providing these revenues.

Advantages of Service Charge.—One of the principal advantages that we see in the application of a service charge is that funds can be provided continuously without the necessity of an annual appropriation. A source of revenue is provided that does not come in direct competition with other budget items that must be included in the tax levy. This is important because the public, as we suggested in the beginning of this paper, are not usually as much interested in matters pertaining to sewage disposal as they are in other budget items and when an economy cut is made in the tax levy or funds are needed elsewhere, sewage disposal operating funds are either forgotten or so reduced as to make efficient operation impossible.

This subject is one to which we should give further thought. It is somewhat removed from the design problem that we usually consider, but fully as important. Design without adequate operation is valueless, and a sewage disposal plant that is operated only when funds happen to be available cannot be depended upon to accomplish the purpose for which it was built.

Acknowledgment.—The above paper was presented at the 9th Iowa Sewage Treatment Conference, held at Ames, Ia.

Sidewalk Zoning.—A new plan for zoning sidewalks has been put into effect by the city of Detroit, Mich. Sidewalks on the chief shopping avenue are marked off into three lanes—one for northbound pedestrians, one for southbound, and an inside lane where window-shoppers can loiter as much as they like. At street intersections painted foot-prints direct people into the right lane of traffic. The plan was first installed for the Christmas shopping season, and met with such success that it is to be adopted permanently.

Zeolite Softening Plant Operating Experiences

Data on Plants of Ohio Valley Water Co. and Sewickley, Pa.

By D. E. DAVIS and J. T. CAMPBELL
Of the J. N. Chester Engineers, Pittsburgh, Pa.

THE data and comparisons herewith have to do with the 4,000,000 gal. pressure type softeners at the plant of the Ohio Valley Water Co. about six miles below Pittsburgh, Pa., and the 2,000,000 gal. open-softener type plant for the Borough of Sewickley, Pa.

Salient Features of Plants.—The salient features and contrasts are briefly summarized in Table I:

The distinguishing differences between the two plants reside in the contrasts between pressure and open type units. The open softeners at Sewickley, being designed for use as filters as well as softeners, operate at usual filtration rates and correspond closely to rapid sand filtration practice as regards head losses, sand rise, etc. The pressure type softeners at the Ohio Valley Water Co. operate at about twice the rate of the open filters, but require materially greater head in the ratio of 32 ft. to 5 ft. The open units permit of ready and continuous observation of the process, which is difficult of accomplishment in the closed units, because of the design.

A wash rate up to 13 gal. per sq. ft. per min. is possible without loss of sand on the open units, although (with the clear water handled) the rate of 7 gal. is found satisfactory. The closed type units have shown considerable losses at the recommended 6 gal. rating, and have given some trouble at four. This is probably due to the fact that their circular cross-section, and cost considerations on the shell limits

View of 2,000,000 Gal. Water Softening Plant of Sewickley, Pa.

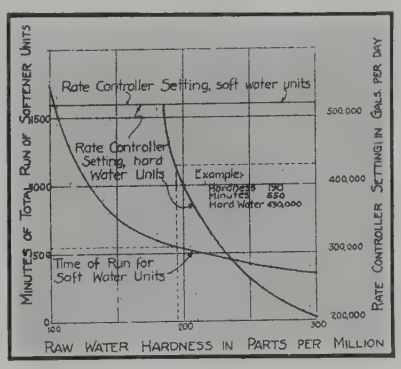


Fig. 2—Curves for Control of Operations

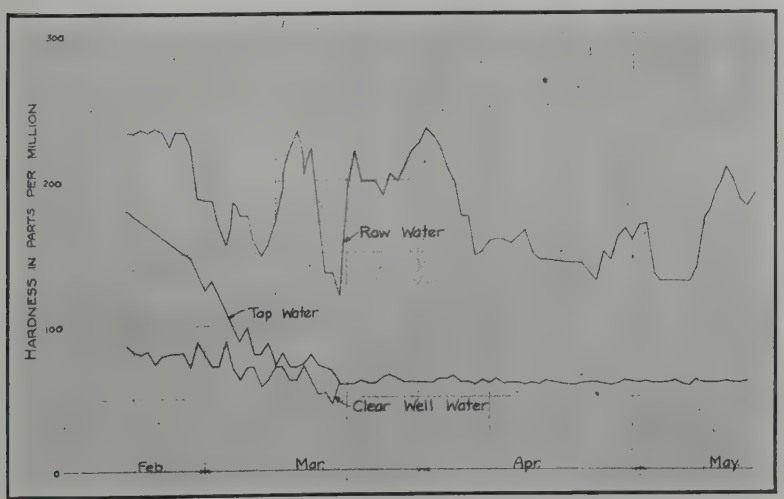


Fig. 1—Operating Results in Terms of Hardness

the distance above the sand line at which the off-take pipe (corresponding to wash trough) can be placed. As the wash water rises it is compelled to converge toward the center at the upper segment of the circular cross-section, thus relatively increasing the velocities. This fact together with the short distance between sand and off-take limits the wash rate and evidently makes it difficult to prevent some loss of sand. Experience thus far with the open units indicates that this difficulty has been obviated in that design, since no losses can be detected.

The sand cross-section in the open unit is rectangular, which is not quite true of the circular closed unit. Standard rate controllers are used on the open unit, whereas the closed unit passes the quantities which the available head loss imposes. In these two features, the open filter appears to advantage, in that the water (and brine solution) seems to travel with greater uniformity downward through the sand thus assuring the fullest regeneration of each sand particle and the maximum removal of hardness per cu. ft. of sand.

Operating Results at Sewickley.—The graph in Fig. 1 presents operating results since the Sewickley plant was started. The hardness of the water reaching the consumers was reduced gradually down to 60 p.p.m. at which figure it has been maintained. This was accomplished by gradually softening the several days' reserve in the borough reservoirs. There was evidently no difference in the taste between the hard and soft water—at least no general comment has been voiced. Some complaints were expected, either for imaginary or real reasons; and ac-

cordingly precautions were taken for making daily bacteriological and chemical analyses on samples taken in the process steps from the crib through to the reservoir. So far as known, not a single complaint was made.

The plant has proved to be quite simple and fool-proof in operation. The zeolite filters are set at a constant rate of about 2 gal. per sq. ft. per min. while the hard water filter is set at the approximate rate shown in the curve of Fig. 2. The second curve indicates the period of run, and by following the procedure there set out, the final product is kept close to 60 p.p.m as may be seen in Fig. 1.

The individual operation consists in turning the effluent of the newly regenerated softener into the soft water clear well, from which it proceeds to the mixed water clear well, there mingling with the hard water effluent from the hard water clear well. The operator usually checks (by soap method) and records the end of the soft water run, and of the "Twilight Zone" or period during which the zeolite bed completes its exhaustion of sodium, and the hardness changes from zero to that of the raw water. The latter part of the entire run usually involves the delivery of hard water through the bed. The operator finishes the total run by closing the raw water valve, and pulling the water to within an inch or so of the sand. He then closes the effluent valve, presses the button to start the brine pump which delivers the brine solution over the bed, and then opens the rewash valve to a calibrated point so as to pull the brine down through the zeolite sand at a rate from 1.5 to 2.0 gal. per sq. ft. per min. After the brine solution approaches the sand line, the

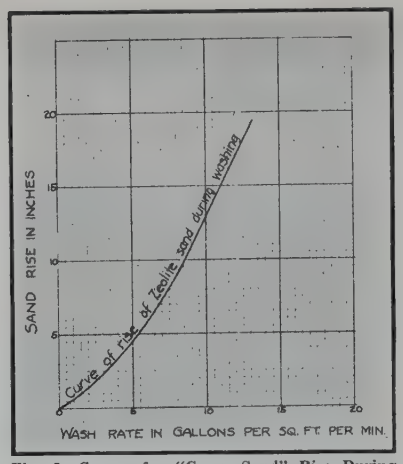


Fig. 3—Curves for "Green Sand" Rise During Back-Washing Operation. Sand: Effective Size .285 mm.; Uniformly Coeff. 1.50

rewash valve is fully opened (to about a 3.2 gal. per sq. ft. per min. rate), and also the influent valve.

During this period of "rinsing" the waste chlorides are washed out to waste through the sewer. After a total elapsed period of approximately 35 minutes, the rinsing is pronounced complete, as determined by tests explained in Fig. 4, and the softener is started on another cycle.

Units have been back-washed on an average of once in 71 hours of service during which period the head on the softener units increases from 4.8 at the start to 7.2 at the end, contrasted to 2.9 and 6.4 for the hard water unit.

The record of 15 consecutive runs is shown in Table II:

During an earlier experimentation period the results for 38 observations indicated a removal of 3,790 grains of hardness per cu. ft. of green sand, and the salt dose .353 lb. per 1,000 grains removal.

This improvement has been effected by changing the dilution of the salt dose, while maintaining the same quantity of salt in all cases. In the earlier runs an 8.6 per cent solution (by weight) was employed, whereas the latter regenerations have been made with a 5 per cent solution. The apparent explanation of the result is that the more dilute solution permits the salt to bathe each sand grain for a longer period than is true of the concentrated solution, and induces a more complete exchange of sodium.

Table I

Plant	Ohio Valley Water Co.	Borough of Sewickley, Pa.
Type	Pressure	Open
Number of Units	4	4
Nominal Cap. in Gals. per 24 hours	4,000,000	2,000,000
Area per sand bed in sq. ft.	208	181.5
Cubic Feet of Sand per Unit	670	470
Direction of flow	Downward	Downward
Rate of flow in gals. per sq. ft. per min.	4.3	2
Rate of flow control	None	Rate Controllers
Wash Rate in gals. per sq. ft. per min.	4 to 6	6 to 13
Sand Rise during Wash in inches	4.7 to 5.6	5.6 to 18.5
Pounds of salt per 1,000 grains removal	.344	.334
Grains removal per cubic foot	3250	4004
Salt Dose	Variable	Constant
Grain Characteristics—Effective Size in m.m.	.31	.285
Grain Characteristics—Uniformity Coeff.	1.50	1.50
Wash Brine & Rinse Water in per cent of plant output	10.5	6.5
Head	32	5

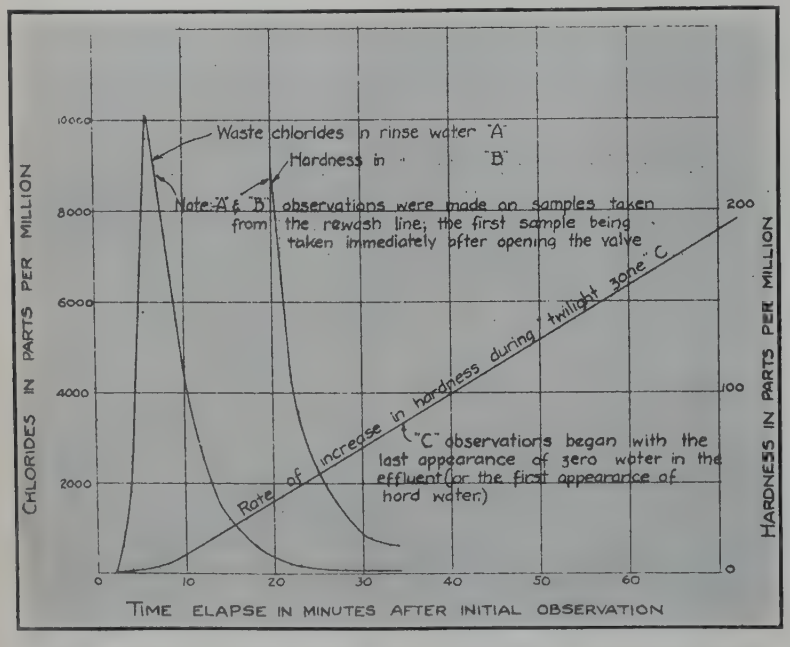

CHLORIDES IN PARTS PER MILLION
HARDNESS IN PARTS PER MILLION
Waste chlorides in rinse water "A"
Hardness in " "B"
Note: "A" & "B" observations were made on samples taken from the rewash line; the first sample being taken immediately after opening the valve
Rate of increase in hardness during twilight zone "C"
("C" observations began with the last appearance of zero water in the effluent (or the first appearance of hard water))
TIME ELAPSE IN MINUTES AFTER INITIAL OBSERVATION

Fig. 4—Hardness and Chloride Changes During "Rinsing" and "Twilight Zone" Periods

The curve of sand rise for green sand during the washing period (Fig. 3) was obtained by lowering a series of test tubes, spaced at two in. intervals, into the space between the sand line and the wash trough, and noting the rise from the sand line to the highest tube in which the sand appeared for each given rate. The curve seems to correspond closely with other observations on quartz sand of similar grain characteristics.

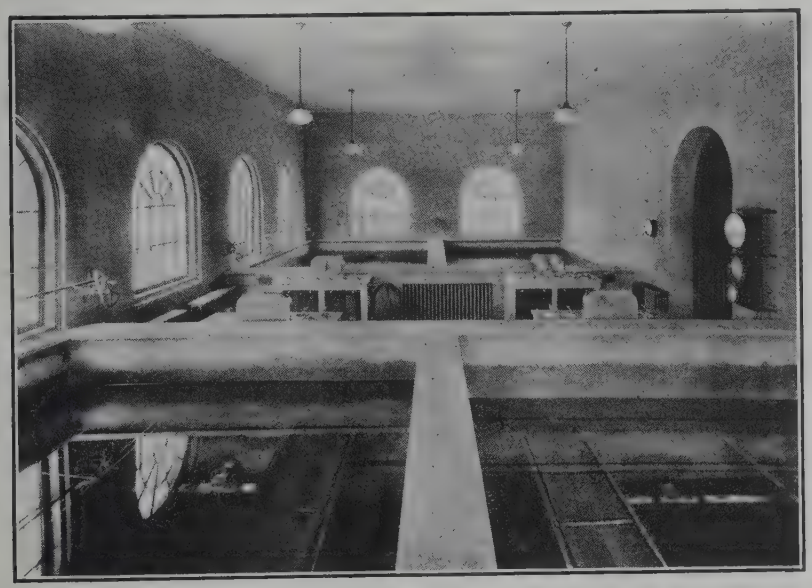
Hardness and Chloride Changes.—Certain technical data respecting the rinsing out of chlorides at the close of the regenerating period and of the action of the zeolite bed towards the end of the softening period are grouped in Fig. 4. At the start of the softening operation the fresh zeolite (or green sand), contains its maximum amount of sodium. As the "hard" water passes through the bed, an ionic exchange takes place through mass action such that the calcium and magnesium in the water "switch partners" with the sodium in the zeolite. For about 90 per

Table II.—Record of 15 Runs on Zeolite Softener Units

	Minimum	Maximum	Average
Hardness of raw water in p.p.m.	185	210	194
Harness of final product in p.p.m.	60	68	63
Length of soft water run in minutes	345	460	398
Length of "twilight zone" in minutes	95	150	123
Length of hard water period in min.	0	60	38
Length of total softener run in min.	495	645	559
Length of regeneration period in min.	20	40	37.7
Hardness removal in grains per cu. ft.	3700	4330	4004
Pounds of salt per 1000 gr. hardness removed	.361	.309	.334

cent of the time until full hardness appears, the bed turns out a water approximating zero hardness. During the latter 10 per cent of the period, or "twilight zone," the water changes from zero to full hardness according to a straight line relationship shown in Curve "C" of Fig. 4.

During the regenerating period there is a reversible reaction, such that the sodium of the brine solution enters the zeolite sand, displacing the calcium and magnesium which are "rinsed" out to the sewer as shown in Curve "A" of Fig. 4. The departure of calcium and magnesium is approximated by Curve "B." The six minute lag between the opening of the rewash valve and the maximum appearance of chlorides represents the waste of water (yet unbrined) which remained in the sand, gravel, etc., when the brine was applied.



Filter and Softening Units of Plant of Sewickley, Pa.

A Correction

In the article on the Design of Sprinkling Filter Distribution Systems published in the June issue there was an error in Formulas No. 1 and 2.

The formulas should read:

$$(1)\quad X=\sqrt{\frac{2(2^2+4^2+6^2\ldots+N^2)}{N}}$$

$$(2)\quad Y=\sqrt{\frac{1^2+2^2+3^2\ldots+N^2}{N}}$$

Sanitary Engineering Courses in the United States

A compilation of data concerning sanitary engineering courses in the colleges of the United States has recently been prepared by the United States Public Health Service. From this summary it appears that there are 16 colleges in the United States at present operating either regular or optional courses in sanitary engineering.

There seems to be considerable difference of opinion among the universities as to the fundamental conception of a sanitary engineering course. The sanitary engineering courses are in reality civil engineering courses with certain appended subjects, such as water supplies, sewage disposal, the bacteriology and chemistry of water and sewage, and a little public health instruction.

Emphasis in both sanitary engineering and public health subjects reflects in practically all the institutions the personality of the professor of sanitary engineering.

The number of sanitary engineering graduates annually is increasing. There is a great variation in the degrees granted by the institutions for equivalent work and also in the names of the courses. In four of the 16 institutions the term of the sanitary engineering courses is either five or six years.

The Model Traffic Ordinance

According to the National Safety Council eleven cities, including Indianapolis; Grand Rapids; Providence; Roanoke, Va.; Port Huron, Mich.; Alton, Ill.; Findlay, Ohio; Boston; Hinton, W. Va.; Fort Dodge, Ia., and Great Falls, Mont., have adopted exactly, or substantially, the Model Traffic Ordinance drawn by the National Conference on Street and Highway Safety. Los Angeles, San Francisco, and Chicago adopted ordinances substantially the same while the model ordinance was in process of formation.

The California Model Ordinance, prepared before and substantially the same as the Model Ordinance, has been adopted by 92 cities in California.

The Michigan Model Ordinance, which is also in substantial agreement with the Model Ordinance, has been adopted by 215 cities and villages in that state.

New Jersey has incorporated most of the provisions of the Model Ordinance in a state law which is thus operative for all municipalities. South Dakota has also adopted Act IV of the Uniform Vehicle Code practically verbatim and this went into effect July 1st for all municipalities in the state.

Municipally-Owned Boiler Plants Must Pay Inspection Fee.—Municipally-owned steam boilers used in plants operated by cities and towns of Arkansas are subject to the payment of the regular inspection fees to the state as are paid by individual owners, it was held in an opinion issued by Attorney General Hal L. Norwood at the request of J. D. Newcomb, chief boiler inspector in the state department of labor. The opinion, which was written by Assistant Attorney General Robert F. Smith, was handed down when the state's right to collect such charges was questioned by Mayor Pat L. Robinson of Little Rock on the contention that the state cannot legally tax one of its political subdivisions. Payment of a bill rendered by the boiler inspection department of the labor department covering inspections of boilers used in Little Rock municipally-owned plants was refused by the city on this interpretation of Act No. 228 of 1927, which requires the inspection of steam boilers within the state as a safety measure. The fees pay the expense of such inspections.

Missouri Valley Water Works to Meet in November.—The 15th annual meeting of the Missouri Valley Section of the American Water Works Association, will be held at Sioux Falls, S. D., on November 6, 7, and 8. R. Rees, Superintendent of the Sioux Falls Water Works, will be in charge of the local arrangements. The office of E. Waterman, the Secretary, is Room 104N, Engineering Building, State University of Iowa, Iowa City, Ia.

Pump Discharge Headers and Pump Piping for Water Works Stations

A Valuable Discussion of a Much Neglected Topic

By F. G. CUNNINGHAM
Of Fuller & McClintock, Engineers, New York City

PROBABLY few important features of water works practice have been so neglected and have been developed in such disregard of sound engineering practice as the piping arrangements used to connect the pumps with the outgoing supply mains, commonly referred to as "header systems." Probably not over one out of ten such systems, as installed, is arranged so as adequately to safeguard reliability of service and obtain maximum reliability consistent with the number of valves and fittings used.

Effect of Local Conditions.—Consideration of this subject in a specific case must take account of varying local conditions that cannot be dealt with in a general discussion such as this. For example, the presence and amount of elevated or hill-top storage beyond the high service pumps has a direct bearing upon the problem. With enough such storage for many days' demand, meager and poorly arranged piping arrangements might still furnish reliable service. Also the number of pumps and of supply mains included in the layout and the number that can be spared without crippling service will influence somewhat the required header arrangements. On the other hand it is obviously unwise deliberately to install header arrangements that might result in shutting down several pumps or several lines even in cases where they might be spared, when a comparatively nominal extra expense or more skill in the arrangement would render such shut-downs unnecessary.

Since most cities have comparatively little or no storage of pressure water, we may assume that for a typical case such storage is absent or too small greatly to be relied upon. Where a considerable amount of it is present the supply that might be obtained from it may be considered in conjunction with that available from the pumping station at the time of the most serious break in the system of header piping, and to that extent might modify the statements about to be made in this paper.

Meeting the Maximum Demand.—Any station should be at least capable of meeting the maximum domestic demand plus fire draft with the largest pump out of service. Preferably this capacity should be available with the two largest pumps out of service, due to the various conditions such as routine repairs, breaks in steam piping or valves or things of that sort to be expected. Most stations have at least one spare pump and many have two, but few have more. Whatever the number of spare units may be, the writer would point out the obvious inconsistency in providing piping arrangements that might readily throw out of service more than the number of pumps that can be spared. It is also desirable and in some cases strictly necessary that full domestic and fire service be maintained with one of the supply mains, or the portion of it necessarily dewatered in repairing any valve, out of service. Considering these factors and the variations in pumping demand normally to be expected, not less than three pumps and three supply mains are required to present an entirely flexible and satisfactory layout for any case where pressure storage is small or absent.

Functions of Good Discharge System.—The functions of a good discharge header may be summarized as follows:

(a) To permit any pump, pipe or valve to be isolated for repairs without crippling service.

(b) To permit any or all pumps to deliver to any or all supply mains, or at least reasonable flexibility in this respect.

(c) To allow of ready operation of essential control valves, especially in emergencies.

(d) To provide convenient access for inspection and repair of control valves and connecting pipes.

(e) To provide reliable and multiple points of connection for essential small water pipes for station service.

The repair or replacement of a valve in a header system is naturally more serious than that of a piece of pipe, since it involves two runs of pipe, that is one on each side of the valve, instead of one run. It is essential, then, to provide two valves between any two adjoining pump connections or supply main connections if it is desired to avoid shutting down more than one unit or line with a single break. With these facts and the above mentioned functions of a good header in mind it is interesting to examine diagrams showing some actual or typical header layouts.

Header Layouts.—Figure 1 shows a flagrant case of poor arrangement actually installed in a recent project. The entire battery of pumps is connected to a single suction main and a single discharge main without valves except on the branch connections to the pumps. The repair of any piece of pipe in suction or discharge lines or of any valve would put the entire station out of service.

Figure 2 shows two pumps and two lines with two valves between pumps. One pump and one line would be shut down by any break or any valve repair. If it were not for the two valves between the pumps the entire station would be shut down. This layout is of interest principally in showing that the number of pumps and of lines is too small.

Figure 3 shows three pumps and two lines of which two pumps and one line would be put out of service by repairs to valves "A" or "B."

Figure 4 shows the same thing except that there are two valves between adjoining pumps making it unnecessary to shut down more thon one pump and one line with a single break.

Fig. 5 shows a three pump layout containing six valves and with a poorly arranged cross connection. Repair to valve "A" would put out of service two pumps and one line. In Fig. 6 is shown a good layout having the same number of pumps, lines and valves, and with each pump discharge split into a separate valved connection leading to each main. With this arrangement the most serious break cannot shut down more than one pump and one supply main, which result would occur through the repair of any one of the six valves. Fig. 7 shows another way of accomplishing the same results as in Fig. 6 and with the same number of valves. The consequences of the most serious valve repair are the same as the Fig. 6, except that the chances of such occurrence are somewhat less since there are only four valves that can produce that result instead of six.

Fig. 8 shows substantially the same arrangement as Fig. 7 except that additional valves are inserted bringing the total number up to 11. Under this arrangement two advantages are gained as compared with the others. First, while the repair of certain valves can shut down either one pump or one supply main, no single repair can shut down both a pump and a supply main. Second, connections are such that there is less likelihood of emergencies re-

quiring the stopping of one pumping unit and the starting of another, which operation might be embarrassing.

Fig. 9 shows the header layout designed by the writer's firm for Memphis, Tenn. The effect of the most serious single break or repair would be to put one pump or one supply main out of service. Due to the arrangement of cross connections it is possible in this layout to continue pumping to all of the mains with all pumps except the one that might be directly affected by a break, thus cutting down the chance of having suddenly to start up a new unit as above mentioned.

Fig. 10 shows a layout devised by the writer in connection with work at Kansas City, Mo. It can be expanded or contracted indefinitely to fit any number of pumps or supply lines. It is founded upon the reasonable basis that one pump and one supply main but not two pumps or two mains may be put out of service simultaneously without impairing service. The features of this arrangement are the way in which the pump discharges and the supply mains alternate in their point of connection to the header and the use of the run-around pipe which may be placed under or above the supply mains or discharge mains. For the number of valves and fittings required this arrangement provides at least as much reliability and flexibility as any arrangement the writer has so far encountered. As compared with the Memphis layout shown in Fig. 9, it provides for the same number of pumps and one additional supply main and requires only ten valves and nine tees instead of 18 valves and 12 tees. By adding eight more valves, that is placing two valves instead of one between each pump connection and the adjoining supply connection, the most serious break would shut down only one pump or one supply main instead of both the pump and supply main, giving substantially the same result as at Memphis.

The arrangements shown in Fig. 9 and 10 make unnecessary the providing of valves in the individual discharge pipes from the various pumps, because any pump can be isolated by closing the header valves lying on either side of the tee for the pump connection.

Fig. 11 differs from Fig. 10 in that the pump discharges and supply mains are in line, doing away with the offset at the header. Without the offset higher velocities and smaller valves and pipes might be used with distinct advantage. The valves in the individual pump discharge pipes are more necessary in this case than in Fig. 10 because without them a supply main would be shut down whenever a pump was opened for repair or inspection. This arrangement is at its best when the number of pumps and number of supply mains can be made equal, as they often can be by a little planning.

Fig. 12 shows another application of the idea already illustrated in Fig. 6, that is, of splitting each pump discharge into two pipes each leading to a different supply main. Fig. 12 is equivalent, as regards the number of valves and the results produced by the repair of a valve, to Fig. 10 or to Fig. 11 if the valves in the pump leads of the latter be omitted. It might be more convenient or economical than either of these in some cases.

Fig. 13 shows the header arrangement actually installed in a large city having the same number of pumps and supply mains as illustrated in Figs. 10 and 12. The interesting points about this layout are the unskillful use which has been made of the number of valves and fittings installed and the failure to provide adequately for maintaining service. Thus repair to valve "A" would shut down three pumps which comprise 75 per cent of the station capacity. Repair to valve "B" would shut down three of the four supply mains. Other combinations would shut down one pump and two supply mains or vice versa. It is interesting to note that by using one of the arrangements shown in Figs. 9 to 12 much better results

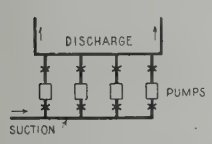


FIG. 1

A POOR HEADER ARRANGEMENT

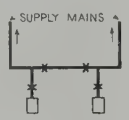


FIG. 2

ONE PUMP AND ONE LINE BY ANY BREAK OR VALVE REPAIR

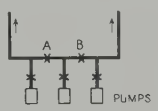


FIG. 3

ONE PUMP AND ONE LINE BY SINGLE BREAK IN LINE
2 PUMPS AND ONE LINE BY VALVE REPAIR

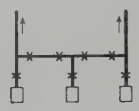


FIG. 4

ONE PUMP AND ONE LINE BY REPAIR OF LINE OR VALVE

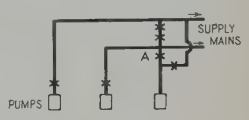


FIG. 5

ONE PUMP AND ONE LINE BY SINGLE BREAK IN LINE
TWO PUMPS AND ONE LINE BY REPAIR OF A VALVE

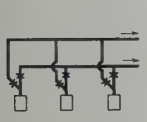


FIG. 6

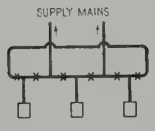


FIG. 7

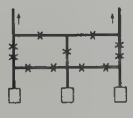


FIG. 8

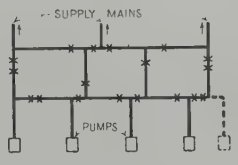


FIG. 9

MEMPHIS, TENN. HEADER
NO SINGLE BREAK OF PIPE OR VALVE CAN PUT OUT OF SERVICE MORE THAN ONE PUMP OR ONE SUPPLY MAIN

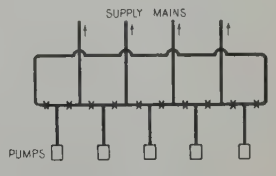


FIG. 10

A GOOD TYPE OF HEADER
WORST BREAK PUTS OUT OF SERVICE ONE PUMP AND ONE SUPPLY MAIN

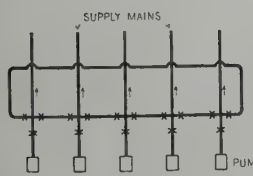


FIG. 11

FIGS 11 AND 12 PROVIDE SAME DEGREE OF PROTECTION AS FIG 10

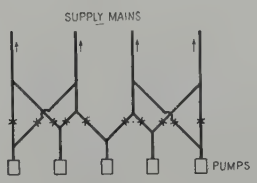


FIG. 12

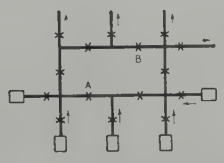


FIG. 13

ACTUAL HEADER IN A LARGE CITY
REPAIR OF VALVE "A" PUTS OUT OF SERVICE 3 PUMPS OR 75% OF STATION CAPACITY
REPAIR OF VALVE "B" PUTS OUT OF SERVICE 3 OF THE 4 SUPPLY MAINS.

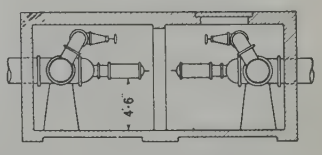


FIG. 14

SECTION OF MEMPHIS HEADER CHAMBER

Figs. 1 to 14—Diagrams Showing Actual or Typical Header Layouts

would have been secured with five less valves and fewer fittings. Or stated in another way, by using three more valves than were actually used and by changing the arrangement it would have been possible to have kept everything in service except one pump or one supply main in the event of the most serious break of a valve.

Most designs could be improved by using more and smaller pumps and mains, particularly the latter. It is often noted that two large mains lead from a station and soon subdivide into say four smaller ones, when at slight cost all four mains could have been led directly from the header, with much greater reliability and flexibility.

Header Details.—In a few places in an effort to secure the utmost reliability, the pipe and fittings in the header systems have been made of rolled steel and the valves of cast steel. The writer believes that as a rule this expensive practice is unnecessary, and is of the opinion that in a suitably arranged header cast-iron fittings and valves are satisfactory. Both fittings and valves however, should be especially rugged and designed for a pressure considerably in excess of the working pressure on the header system.

Where the fittings are larger than 16 in. in diameter it is a good plan to have each of them tapped and plugged at a number of points to make sure that the casting is not unduly eccentric or thin on one side. This precaution is worth while in view of the fact that special castings are not ordinarily put under a pressure test or measured for wall thickness in the foundry. To avoid danger of joints pulling apart it is best to make all of the pipe and valves in the header system flanged. In layouts such as that shown in Figs. 10 and 11 the run-around pipe, since it contains no branches, can be made of steel.

In order to make all parts of the header readily accessible the header should be enclosed in a masonry chamber, with convenient access provided from the pumping station and from the surface. Fig. 14 shows a section of the header used at Memphis, the plan layout of which is shown in Fig. 9. The header system is 24 in. in diameter throughout. The valves are operated hydraulically from a control table located inside of the pumping station near the front wall. The operating water for the valve cylinders is supplied ordinarily by water from the discharge mains, but the boiler feed pumps are also connected to the operating table through a reducing valve for emergency use. When a lever is moved to operate a valve the waste water flows from a pipe at the back of the table and into a funnel connected to the sewer, giving the operator a visible indication when the valve is moving and when it has stopped moving. Except when the table is in use the water supply and water waste connections to the table are kept cut off by valves controlled from the top of the table, for the purpose of preventing unauthorized persons from tampering with the valves. A black line diagram similar to those shown here is framed and mounted at the back of the table and on it every valve is numbered so that the operator can secure a clear idea of what operations are required for any contingency.

Referring to Fig. 14, it will be noted that there is plenty of space below the header piping and valve cylinders to move any of the valves or fittings across the floor to a point underneath one of the hatchways in the roof. Without this space the removal or insertion of a fitting would be quite difficult. Valve cylinders are all placed horizontally so that there is no tendency for the valves to creep when the pressure is cut off from the cylinder. The bypass valves are all placed on top of the main valves and with the operating stems projecting inward toward the center of the loop so that they all can be reached without climbing over the header piping. A large drain leads from one corner of the header chamber to the sewer so as quickly to carry off water that might come from a break in the header system or the pumping station basement.

The Memphis layout illustrates how the various requirements for ready and convenient operation and for access to the header were met in this one case. Whether hydraulic or electric valves should be used in a given case as against hand operated valves, depends considerably upon the number and size of the valves, but there is no doubt that even in small sizes power operation is advantageous and will speed up the valve operations necessary in emergencies. Hydraulic valves are cheaper than electrically operated valves and if connected to the boiler feed pumps or some similar emergency source of water supply, are probably more dependable as to source of power supply in most stations.

It is often advantageous to use high water velocities and relatively small pipe and valves in the header system. This not only keeps down the cost but promotes quickness of operation, ruggedness and reliability as compared with larger piping. In any of the loop arrangements such as shown in Fig. 10, water ordinarily flows both ways around the header, and normally velocities are moderate. When the loop is interrupted by closing valves, velocities will be high, but considering the short time such conditions exist and the advantages to be gained by the smaller sizes a few feet of extra head loss is not a powerful factor.

Except as the need for reliability may be modified by the pressure of low service storage, low service discharge headers should be laid out with the same care as high service headers.

Suction Connections.—On account of the low pressure on the suction side of the pumps and of the greatly lesser likelihood of breaks occurring there, it is unnecessary to have suction arrangements anything like as thoroughly valved and as complex as the discharge header. There are certain criteria, however, which should be met. The suction connection from each pump should lead directly to the suction well or to a concrete conduit, which may be regarded as the equivalent of a suction well, independently of the other pumps. The suction pipe for each pump should project several feet below the lowest water level in the suction well or suction conduit so that the pump may be primed or started or stopped without interfering with the suction to the other pumps. If these requirements be met about the only other requirement to be considered is that it should be made possible to gain access to one part of the suction well or suction conduit and to the individual pipes connected thereto without interrupting service of the remaining pumps. At Memphis there are two separate suction conduits, one arranged to supply three pumps and the other two pumps. Each conduit is controlled by a sluice gate and each sluice gate by double stop-plank grooves, so arranged that either sluice gate or either suction conduit can be isolated without shutting down more than half of the pumps normally available.

Under other circumstances the same effect could be produced with a single suction conduit merely by placing stop-plank grooves at intervals along the length of the conduit and by feeding the conduit from both ends. This is done in the Dallas design where the grooves divide the conduit into three parts, and where the grooves are covered with plates set flush with the basement floor and designed to take the uplift of a full clear water basin. In this case the basin will be lowered when the conduit is to be entered.

The above described suction arrangements are probably sufficient for the average case. For one thing they eliminate the most common fault in suction piping which is to connect the pumps to a single vacuum suction header invariably resulting in troubles in priming the pumps or in keeping them primed during operation.

Foot valves in suction connections are to be avoided, first, because they introduce in an inaccessible location a device likely to require attention and repair, and second, because they are likely to subject the pumps and suction piping, especially centrifugal pumps, to severe shocks caused by water hammer when the checks close.

Check Valves.—Check valves on the discharge side of centrifugal pumps are practically essential in all ordinary cases. In one case where they were omitted a sudden tripping of the pump, and the resulting back flow of water at

high velocity, burst the pump casing. Another danger when check valves are omitted is that the back flow of water will over-speed the pump and cause damage through centrifugal stress before it can be shut off.

For these reasons check valves in the discharge lines of centrifugal pumps seem to be a necessary evil, although the way in which some of them slam shut and cause water hammer when the power it cut off, is a matter of concern to many operators, particularly where the valves are 24 in. or more in diameter. Relief valves should be provided where the danger of hammer is great. After experiencing this difficulty in a number of installations, the writer took up with a valve manufacturer the question of designing a valve which would close with less shock. A multiport valve was required and it was decided to depart from the standard design of that manufacturer to the extent of increasing the number and cutting down the diameter of the ports and making the flaps of a tough bronze instead of bronze faced cast iron. The reduced weight of the flaps and the reduced distance through which they traveled in closing apparently produced a good result as these particular valves close without noise even when the pump is suddenly tripped. Of course, the Larner-Johnson, Automatic Cone or other special combination stop and check valve can also be used to prevent hammer and can be used in sizes much too big for a good gate or check valve. The writer has seen fit to mention this detail because the shocks in many such lines are a serious potential source of unreliability.

The foregoing discussion of headers and pump piping is offered on the basis that it may point out proper methods of approaching the subject rather than with the idea that it will afford a suitable layout fitted to each particular case. Local conditions must be considered in all cases. In every case, however, authorities responsible for planning the piping arrangements should submit their proposed arrangements to the insurance inspection department having local jurisdiction. In all cities above 25,000 population, the National Board of Fire Underwriters, through its Engineering Department, makes a detailed study of the entire water system and it is highly desirable that their criticisms should be secured before the work is built. They are in possession of an abundance of information and know the good and bad features of all important water systems in the country as viewed particularly from the standpoint of reliability of service.

Acknowledgment.—The foregoing is an abstract of a paper presented June 25 at 49th annual convention of the American Water Works Association.

Wages and Hours of Labor of Common Street Laborers in 1928

The entrance wage rates and regular hours of labor of unskilled street laborers directly hired by more than 2,600 cities and towns in the United States have been compiled by the Bureau of Labor Statistics. The full compilation, giving details by individual communities, will appear in bulletin form. A brief summary of this report is given in the June Monthly Labor Review, a publication of the U. S. Department of Labor.

The rates shown are those paid by the municipalities to common laborers when first engaged on the construction, repairing, or cleaning of streets. Higher rates may be paid for greater skill or after a period of service.

The questionnaires for this inquiry were sent out by the United States Bureau of Labor Statistics, under date of October 31, 1928, to all cities and towns having a population of 2,500 or over according to the 1920 census. About 93 per cent of these municipalities replied.

Classified Hourly Wage Rates.—In Table I are given classified entrance wage rates for common street labor, the number of municipalities in each state paying each classified wage rate, as well as the percentage of all municipalities paying each classified wage rate being shown. Of the 2,626 municipalities reporting, 593, or 23 per cent, were paying 40 and under 45 ct. per hour and 553, or 21 per cent, were paying 50 and under 55 ct. per hour. While 896 or about 34 per cent, paid under 40 ct. per hour, only about 15 per cent paid 55 ct. or more.

Classified Weekly Hours of Labor.—In Table II, classified working hours per week of unskilled street laborers are presented. The number of municipalities in each state whose laborers work each classified number of hours per week are shown, and the percentage of all municipalities whose street laborers work each specified number of hours per week are also set forth. Of the total cities and towns reporting, 1,053, or 40 per cent, had a 48 hour

Table I.—Classified Hourly Rates of Wages of Unskilled Common Labor Hired by Cities for Work in Constructing, Repairing or Cleaning Streets

State	Number of cities reporting	Number of cities in which hourly wage rates of street laborers were—														
		Under 15 cts.	15 and under 20 cts.	20 and under 25 cts.	25 and under 30 cts.	30 and under 35 cts.	35 and under 40 cts.	40 and under 45 cts.	45 and under 50 cts.	50 and under 55 cts.	55 and under 60 cts.	60 and under 65 cts.	65 and under 70 cts.	70 and under 75 cts.	75 and under 80 cts	80 and under 85 cts.
Alabama	33		9	14	6	4										
Arizona	15					3	4	4		2	2					
Arkansas	38	1		10	20	4	2	1								
California	103						3	9	3	38	20	21	7	1		1
Colorado	26						7	11	2	4	1	1				
Connecticut	30						2	3	6	12	4	1	1		1	
Delaware	3					1	1	1								
District of Columbia	1							1								
Florida	26		4	6	6	7	2	1								
Georgia	54	2	23	19	6	2	2									
Idaho	20						4	8	2	3	2	1				
Illinois	166				1	10	16	32	10	39	12	14	10	3	17	2
Indiana	90				2	16	26	31	4	9	2					
Iowa	79				2	12	17	34	5	8			1			
Kansas	58						16	29	4	8	1					
Kentucky	41		1		15	11	3	4	1	4	1	1				
Louisiana	30	1	2	11	11	2	2	1								
Maine	25					5	10	10								
Maryland	18				1	4	4	4	3	2						
Massachusetts	165						4	14	8	73	19	27	19	1		
Michigan	92					6	14	36	12	17	3	3	1			
Minnesota	56					8	15	15	3	10	4	1				
Mississippi	29		2	11	13	1	2									
Missouri	58				3	15	11	21	4	4						
Montana	17							1		5	4	6	1			
Nebraska	29					1	7	20	1							
Nevada	2									1	1					
New Hampshire	26					2	6	7	2	8	1					
New Jersey	114					2	1	9	9	44	16	20	10		3	
New Mexico	11				3	4	1	3								
New York	162						5	40	20	57	11	15	7		7	
North Carolina	52			15	30	6		1								
North Dakota	12						3	8	1							
Ohio	139				1	5	13	34	21	42	13	10				
Oklahoma	58				2	9	9	28	1	8		1				
Oregon	22					1	1	4	1	10	3	2				
Pennsylvania	292				1	7	28	88	54	90	19	5				
Rhode Island	21						2	5	4	8	2					
South Carolina	30		13	16	1											
South Dakota	14						3	8	2	1						
Tennessee	39		2	12	20	2	2	1								
Texas	106		8	5	28	26	17	16	1	4				1		
Utah	15						8	4		2	1					
Vermont	14					1	4	7	1	1						
Virginia	38				19	11	6	2								
Washington	33							3		17	7	6				
West Virginia	34				1	7	2	13	3	8						
Wisconsin	82				3	6	28	20	10	10	3	2				
Wyoming	8							1		4	2			1		
Total	2,626	4	64	119	195	201	313	593	198	553	154	137	57	7	28	3
Per cent	100	(1)	2	5	7	8	12	23	8	21	6	5	2	(1)	1	(1)

Table II.—Classified Hours per Week Worked by Unskilled Common Labor Hired by Cities for Work in Construction, Repairing or Cleaning Streets

State	Number of cities reporting	Number of cities having working week of—							
		44 hours	Over 44 and under 48 hours	48 hours	Over 48 and under 54 hours	54 hours	55 hours	Over 55 and under 60 hours	60 hours
Alabama	33		1	3	2	5	6	7	9
Arizona	15			15					
Arkansas	38	1	1	7		8	5	2	14
California	103	25	3	73		1			1
Colorado	26			25					1
Connecticut	30	4	1	9	9	7			
Delaware	3		1		1				1
District of Columbia	1			1					
Florida	26	1	2	5	3	6	3	1	5
Georgia	54	1	1	1	8		18	6	19
Idaho	20			20					
Illinois	165	[1] 26	5	68	21	29	1		15
Indiana	90	2	2	18	14	19	9	1	25
Iowa	78	3		19	3	19		2	32
Kansas	58	1		55		1			1
Kentucky	41	[1] 6	1	7	5	10			12
Louisiana	30	2	1	2	2	10	1	2	[2] 10
Maine	25	1		5	2	17			
Maryland	17	2		5	7	2			1
Massachusetts	164	[1] 43	12	93	9	6	1		
Michigan	92	1	6	12	17	31		2	23
Minnesota	55	1	1	19	1	8		1	24
Mississippi	30	1	1	5	3	6	1	4	9
Missouri	58	3		23	5	15		1	11
Montana	17			16					1
Nebraska	29			16		2			11
Nevada	2			2					
New Hampshire	26			7	5	14			
New Jersey	114	27	13	36	29	8	1		
New Mexico	11	2		8	1				
New York	161	31	11	89	5	18			7
North Carolina	52			1	3	1	29	2	16
North Dakota	12			6					6
Ohio	139	25	15	72	7	8	4		8
Oklahoma	58	[3] 1	1	54					2
Oregon	22	1		21					
Pennsylvania	290	14	16	74	70	58	33	9	16
Rhode Island	21	2	1	3	6	8			1
South Carolina	30			1	4		17	1	7
South Dakota	14			2		6			6
Tennessee	39	1	1	3	4	5	12	1	[3] 12
Texas	106	[1] 9	4	75	6	6		2	4
Utah	15			14				1	
Vermont	14		1	2	2	9			
Virginia	38	2	2	2	11	6	9	1	5
Washington	33	2	2	29					5
West Virginia	34	1	2	9	5	12			
Wisconsin	82	[4] 3	1	13	12	17	4	3	29
Wyoming	8			8					
Total	2,619	[5] 245	109	1,053	282	378	154	49	[6] 349
Per cent	100	9	4	40	11	14	6	2	13

[1] Including 1 with less than 44 hours per week.
[2] Including 1 with more than 60 hours per week.
[3] Less than 44 hours per week.
[4] Including 2 with less than 44 hours per week.
[5] Including 7 with less than 44 hours per week.
[6] Including 2 with more than 60 hours per week.

week and 13 per cent a working week of less than 48 hours. On the other hand, 46 per cent had a working week of over 48 hours. While the street laborers in 9 per cent of the cities worked 44 hours or less a week, in 13 per cent of the cities such laborers had a 60-hour week.

Rotating Overhead Spray Cures Precast Concrete Sewer Sections

A new sewer under construction in Waterbury, Conn., is of considerable interest because of its location in the bed of the Naugatuck River. The sewer is of precast concrete construction, the units being 54 in. in diameter and 4 ft. long.

Because of the location of the sewer under water, particular care was taken to secure an impervious concrete of high strength. Proper curing was deemed especially important. The accompanying photograph shows the casting yard, illustrating the method of curing the finished sections. Simple A-frames were set up with roller bearings at the tops. A line of perforated pipe was laid upon these roller bearings and connected at the end with a small water motor of the type used to rotate large lawn sprinklers. When water was turned through the piping, it fell in sprays, keeping the curing sections in a cloud of moisture. The sprinkling was carried on continuously—day and night. During the daytime the spray was supplemented by a boy with a hose, who patrolled the units and sprinkled portions of the concrete pipe not reached by the spray. The photograph was taken shortly after the manufacture of the pipe was begun and shows only one line of sprinkler pipe. Later two and three lines of pipe were used so that the precast pipe could be kept thoroughly wet for 10 days in accordance with the requirements of the specifications.

As shown in the illustration, the mixer was placed on a platform at the end of rows of forms. Concrete was transported on a raised runway. Concrete was usually placed in the forms between 10 and 2 o'clock, and it had usually set sufficiently to allow removal of the forms by the next morning. The forms were then stripped and the pipe was moved into line below the sprinkler for curing.

The pipe used in this project is being manufactured by the Newark Concrete Pipe Co., of Newark, N. J. The sewer is being built under the direction of Robert A. Cairns, City Engineer of Waterbury, with Truman M. Curry, Jr., Assistant Engineer, in charge of design, location and construction work.

Sprinkler System Used for Curing Precast Concrete Sections for Naugatuck River Sewer in Waterbury, Conn. The Overhead Rotating Spray System Was Found Very Effective in Securing Proper Curing

Air-Port Design Competition

The Lehigh Portland Cement Company is sponsor of a competition for the design of a modern air-port, details of which may be obtained by writing the company at Allentown, Pa. The competition will close Nov. 18, 1929. Engineers, architects and city planners may compete. Entries consist of two sheets, each containing two principal drawings. Fourteen cash prizes aggregating $10,000 will be awarded, as follows:

First prize	$5,000
Second prize	2,500
Third prize	1,000
Fourth prize	500
Ten honorable mentions, each	100

Acquiring the Research Habit

By HALBERT P. GILLETTE

KNOWLEDGE consists in knowing facts; wisdom, in knowing their relationships. Perhaps this is a rather arbitrary distinction between these two words, but it serves at least to emphasize the difference between mere fact gathering and the discovering of the significance of facts.

"Those who refuse to go beyond a fact rarely get as far as fact," said Huxley, and he added, "anyone who has studied the history of science knows that almost every great step therein has been made by the anticipation of nature, that is, by the invention of hypotheses which, though verifiable, often had very little foundation to start with."

In a letter written in 1861 Charles Darwin said: "About 30 years ago there was much talk that geologists ought only to observe and not theorize; and I well remember someone saying that at this rate a man might as well go into a gravel pit and count the pebbles and describe the colors. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service." At another time he said "I am a firm believer that without speculation there is no good and original observation."

Coming from a man who was one of the most painstaking of observers and experimenters, and the author of a theory that is without equal in its effect upon biological science, such an attitude toward the framing of scientific hypotheses is not to be brushed aside. Darwin's biographers all say that he was exceptionally prolific in devising hypotheses to explain phenomena. One of them quotes him as saying: "Hence it has become a passion with me to try to connect all such facts by some sort of hypothesis." And again: "I have steadily endeavored to keep my mind free so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as the facts are shown to oppose it." However, he did not live up literally to this last statement, for several times when his theory of evolution seemed to be seriously controverted by certain facts, he clung to it. Many a competent naturalist, such as Agassiz, cited many a fact that seemed to be unanswerable by Darwin's theory, yet Darwin adhered to his belief in its fundamental soundness. Apparently he reasoned that a new theory should be judged mainly by what it explains rather than by what it fails to explain.

The doctrine that was prevalent a century ago among geologists and astronomers, to which Darwin made reference in the letter above quoted, still controls not a few scientists. Recently an experienced astronomer wrote the editor that the time is not yet ripe for theorizing about the origin of our solar system. If Darwin is right, the time was ripe for such theorizing when Galileo made his telescope. Commenting directly upon such matters. Darwin said: "How many astronomers have labored their whole lives on observations, and have not drawn a single conclusion."

In a letter written in 1871 he says: "I have been speculating last night what makes a man a discoverer of undiscovered things, and a most perplexing problem it is. Many men who are very clever—much cleverer than the discoverers—never originate anything. As far as I can conjecture, the art consists in habitually searching for the causes and meaning of everything which occurs."

There is a world of truth in this last statement, but the word "habitually" should have been printed in capitals. How to become an habitual seeker of causes and meanings is a great problem. Darwin not only denies that his training in two universities failed to make him such a seeker, but he asserts that his university time was mostly wasted: "During the three years which I spent at Cambridge my time was wasted, as far as the academical studies were concerned, as completely as at Edinburgh and at school." He was born in 1809, and when he was at Cambridge physical science was little taught. Yet it is rather surprising to hear so modest a man say: "I consider that all I have learnt of any value has been self-taught." Surely he did not have in mind what he learned from books, but regarded that as part of his self-taught knowledge. The opening chapter of his "Origin of Species" contains many references to books and articles by men who had had more than mere glimpses into the secrets of evolution, and his biographers tell of his painstaking indexing and abstracting of books and articles throughout his long and industrious life. We are, all of us, prone to regard what we learn in that manner as being "self-taught." Henry Ford, in his book, makes the same error, for he speaks of his careful reading of all that could assist him in designing automobiles, and then adds that he learned most from his own experiments. That he learned most from published matter is beyond question when consideration is given to what he himself added to the art of automobile designing.

When we see what Darwin accomplished without much aid from his university training, and what Ford accomplished with no such aid, and remember that many another originator and inventor has succeeded greatly in spite of little scientific schooling, it should be evident that most of science can be learned from books and articles, without the assistance of teachers. Moreover, it is almost self-evident that any studious man of middle age has necessarily learned vastly more from the printed page after his formal schooling ended than he learned at school.

Darwin's rebellious attitude toward Cambridge may have come from his perception that Cambridge did nothing to make him an habitual inquirer as to the causes of things. If so, then most of our American graduates of colleges and universities could justify a similar rebellion. We have yet a long road to travel in America before it is generally realized that the primary function of schooling is to make the students habitual inquirers. Only in a few American institutions of higher learning is training conducted continuously so as to effect that result. Studying the fundamental principles of science does not accomplish that result. Mathematical training does not. Then what does? Nothing but repeated practice in systematic searching for the answers to questions, and particularly to questions that can be answered only by the collecting and weighing of many facts.

If it be objected that we can not all be Darwins or Fords, and that such men will always find ways of training themselves, then the objector has completely failed to understand the primary object of mental training. It is not to acquire knowledge, or even to acquire wisdom, that we take courses of study in college, for neither is acquirable to any considerable extent during the schooling period. It is to become habituated to secure and analyze facts with a view to answering some definite question.

The question may be, What is the most economic pavement to lay for the service that it will probably be required to render? Simple though it sounds, this is a very difficult problem in many cases. The question may be, What business or profession should I enter and where? More than 99 per cent of men guess at the answer, for they have never been habituated to solve problems by the fact-gathering method. The question may be, Why is my business unprofitable although my competitor is thriving? No solution is there for such a problem other than fact-gathering and analysis. Nearly all the problems in life are of these sorts, and then solution is correctly made only by those who are either instinctively fact-hounds, or have become habituated to searching for usable facts and their significance.

Mechanical Developments in Water Treatment Practice

Use of Mechanical Clarifiers and Agitators in Water Treatment

By C. T. LEANDER
Branch Manager, The Dorr Co.

IN this paper the discussion will be confined to the unit operations of presedimentation, sedimentation, chemical softening and chemical coagulation, their relationship one to another, and their relationship to the other unit operations in several typical flowsheets which have been found effective in the case of three frequently encountered treatment problems.

The mechanical equipment for carrying out these unit operations which we are qualified to discuss, are the Dorr traction clarifier and the Dorr impeller agitator.

The Clarifier.—The Dorr Traction Clarifier, as shown in the accompanying illustration, is a continuously cleaned sedimentation basin which, when receiving as its feed raw or chemically dosed water introduced through submerged ports along the influent side, overflows continuously a clarified water across a weir at the effluent side opposite and discharges a thick sludge from a bottom connection. It operates continuously, is never shut down for manual cleaning and duplicate or stand-by units are not needed. The total tank contents are at all times available for detention purposes as sludge is removed at the rate of deposition. The old device which it displaces is the well known settling basin, rectangular in shape and constructed of concrete and masonry.

The Agitator.—The Dorr impeller agitator was developed to satisfy the conditions prevailing in water treatment, that is, effective turnover of the raw water to give homogeneity throughout but at a velocity at which flocs will form and build up rapidly. The illustration of a cross section through such an agitator is almost self explanatory. A slowly revolving marine impeller in a cylindrical draft tube induces a gentle circulating motion of the tank contents, upward through the tube and downward in the annular space surrounding it. A velocity between .5 ft./sec. and 1.5 ft./sec. is maintained as at this velocity flocs build up readily, yet do not settle on the tank bottom. In order to insure complete treatment of all the water with a minimum of short circuiting, two or three agitator tanks, arranged in series, are recommended. Vertical baffles, at right angles to the flow line between influent and effluent ports, and extending from the bottom to slightly above the water level, minimize swirling and cause all of the water to pass through the draft tube at least once.

These Types of Treatment.—With this brief outline of the salient features of the clarifier and agitator, consideration may be given to the development of flowsheets for handling the following three common problems:

	Character of Raw Water	Treatment	Chief Unit Operations
1.	Turbid and soft	Clarification	Coagulation Mechanical sedimentation (Plain sedimentation) Filtration
2.	Clear and hard	Softening	Softening Mechanical sedimentation Plain sedimentation Filtration
3.	Turbid and hard	Clarification Softening	Mechanical presedimentation Coagulation and softening Mechanical sedimentation Plain sedimentation Filtration

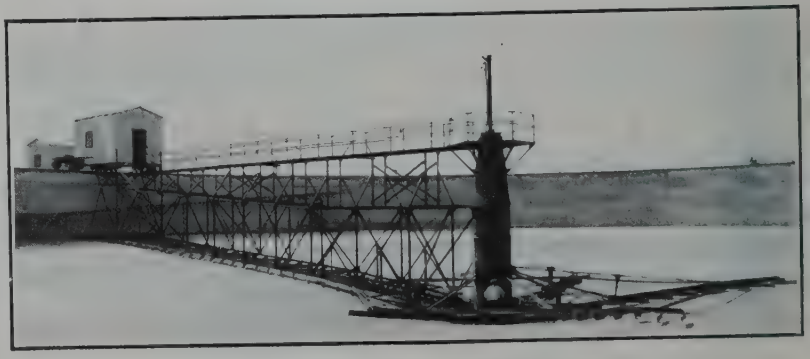
These three types of treatment are well known. It is conservatively estimated that they cover 80 per cent of the problems encountered in water works practice. Simple as they are, they have been the subject of much study by the leaders in the development of modern practice, as Hoover, McDonnell, Graf, Flemming, to mention only a few, have been instrumental in moulding practice in each case to a point where chemical and mechanical controls approach very closely to perfection. As this paper cannot attempt to deal with all phases of improved technique, it will attempt simply to show the relationship of mechanical clarifiers to each of these three common problems, quoting operating figures at typical installations insofar as possible.

Turbid, Soft Water.—Water containing excessive amounts of suspended solids, yet in other respects, such as hardness, suitable to domestic and industrial use is found chiefly along the seaboard as distinguished from the great hard water section in the mid-western and central portion of the country. The accompanying diagram shows diagrammatically in simplified form, the unit operations.

The turbid water is treated with suitable coagulants, such as alum or iron sulfate, and properly conditioned or coagulated in a series of agitation tanks in which mixing is maintained at a velocity suited to rapid flocculation. In the mechanical sedimentation tank the floc settles rapidly, yielding a clarified effluent from which the slight remaining turbidity may be readily removed on rapid sand filters. Chlorination after filtration may or may not be employed, depending upon local conditions.

The plant of the city of Lancaster, Pa., is typical of this type of treatment. The tabulation which follows gives the salient features of the chemical treatment and the operating results of the mechanical clarifier.

Clear, Hard Water.—Clear water, excessively hard, is a common occurrence in the great hard water section of the



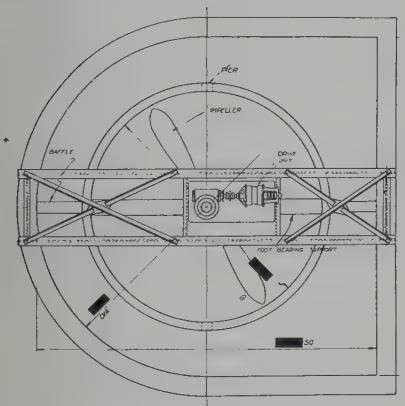
The Dorr Traction Clarifier at Kansas City, Mo.

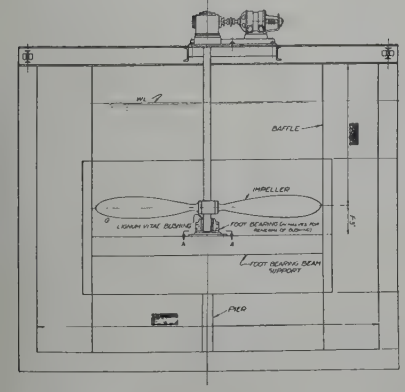
Table I—Treatment of Turbid Water at Lancaster, Pa.

Year Installed	1926
Chemical coagulants used	Alum
Flow M.G.D.	9—12
Size Dorr traction clarifier	80 ft.
Detention provided	1 hr.
Feed concentration P.P.M.	Max. 2,000
Feed concentration P.P.M.	Aver. 80
Overflow concentration P.P.M.	15—18
Clarification efficiency	80—90%

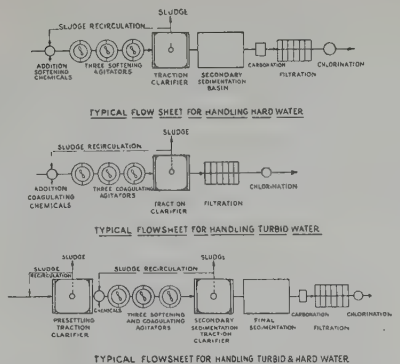
middlewest and the southwest. This condition is particularly prevalent in the states of Ohio, Illinois and Michigan, where many modern softening plants are found. The diagram illustrates a type of treatment which is used successfully for handling water of this character.

The hard water is dosed with the correct amount of softening chemicals, and the softening reaction and formation of flocs completed in the agitator tanks which follow. In the mechanical sedimentation basins the bulk of the floc is removed so that the duty on the plain sedimentation tank is greatly reduced, thus minimizing sludge accumulation and the need for frequent cleaning. The settled water is finally treated on rapid sand filters, preceded by carbonation and followed by chlorination if local conditions make these additional steps desirable.





Dorr Impeller Agitator



Flow Sheets for Handling Various Types of Water Using Agitators and Clarifiers

In the recently designed water softening plants for the cities of Fostoria, O., Bloomington, Ill., and Boca Raton, Fla., plain sedimentation tanks have been eliminated. Single stage sedimentation in mechanical clarifiers yields an effluent containing such a small amount of suspended solids that final treatment on rapid sand filters is all that is required. Such plants as these are 100 per cent mechanically operated as far as sludge handling is concerned.

Table II gives operating data at five representative waterworks handling hard water. The treatment in general follows the lines laid down in the diagram. The raw water is clear in most cases, as it comes from deep wells. The Dorr clarifiers, which in each case remove the bulk of the floc ahead of plain settling basins, effect a 75 to 98 per cent removal of the precipitated solids, thus greatly reducing the duty on the subsequent equipment.

Turbid Hard Water.—That portion of the country which is drained by the Mississippi, Missouri, Arkansas and Red Rivers is noted for the high turbidity and moderate hardness of its water supply. These hard river waters contain turbidities ranging from 3,000 to 10,000 parts per million. Ofter for as long as a week the turbidity stays at 18,000 p.p.m. or higher, while for short periods turbidities of 40,000 p.p.m. have been observed. The difficulty of keeping non-mechanical sedimentation equipment in service under such conditions, may be visualized by considering the following. A turbidity of 10,000 p.p.m. is equivalent to 5,830 cu. ft. of 80 per cent moisture sludge per million gallons of water treated. With such an average turbidity, a sedimentation basin having a detention of 24 hours will be full of mud in 23 days, with 12 hours' detention in 11.5 days and with 6 hours' detention in 5.7 days.

The manual cleaning of settling basins in this section used to be a frequent and major operation, often requiring several weeks' work and the use of a large number of tractors, motor vehicles and teams in addition to a large force of men. Nowhere, it is safe to say, has the mechanically cleaned sedimentation basin helped so greatly in water works practice. An approved layout for handling turbid hard water provides for mechanical presedimentation ahead of chemical treatment and secondary mechanical sedimentation following chemical treatment as shown on the diagram.

The highly turbid raw water enters the mechanically cleaned presedimentation basins depositing therein about 90 per cent of suspended solids which are continuously discharged into the river. The presettled water is thereupon mixed with suitable softening chemicals, agitated at a velocity conducive to rapid flocculation and then resettled in the mechanically cleaned secondary sedimentation basin. The overflow from these, containing only a small amount of suspended material, is given a long detention in simple sedimentation tanks and filtered with or without prior carbonation and subsequent chlorination as the situation may require.

With such an arrangement the difficulties attending the handling of highly turbid waters largely disappear. Practically all of the mud and precipitate is removed and disposed of mechanically, thereby reducing the deposition in the final non-mechanical basins and filters to insignificant volume. Presettling furthermore, by reason of the low tur-

Table II—Treatment of Hard Water

Year Installed	Beverly Hills, Cal. 1928	Hinsdale, Ill. 1925	Newark, O. 1922	Granville, O. 1925	Miami, Fla. 1925
Chemical softeners used	Lime—alum	Lime—soda ash	Lime, soda ash—alum	Lime—alum, soda ash	Lime—alum
Flow M.G.D.	5	3	6	1	10
Size Dorr clarifiers	1-60 ft.	1—28 ft.	1—40 ft.	1—22 ft.	1—60 ft.
Detention provided	60 min.	60 min.	22 min.	42 min.	60 min.
Clarifier Feed:					
Alkalinity P.P.M.	7.8—8.0 P.P.M.	375	42	365	247
Soap hardness	220 P.P.M.	472	275	445	295
Clarifier Overflow:					
Alkalinity	.....	110—140	40	82	38
Soap hardness	130 P.P.M.	90—120	87	125	86
Clarifier Sludge:					
Per cent water	.....	.....	85%	90%	95%
Per cent removal susp. solids	93.5%	75%	98.5%	90—94%	.....
Treatment after mechanical clarification	1. Secondary Alum coagulation 2. Secondary sedimentation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration 4. Chlorination	1. Secondary sedimentation 2. Carbonation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration

bidity effluent, results in smoother plant operation, simpler chemical control, practically halves the cost of chemicals for coagulation and softening and reduces the cost of the water wasted with the sludge, as this water has not been given the expensive chemical treatment. Furthermore, the return of a portion of raw sludge to the influent channel of the presedimentation clarifier improves the rate of settlement, presumably through entrainment of fines. A similar recirculation of chemically treated sludge in the case of the secondary clarifier has been shown to accelerate the rate of softening, probably due to a reduction in supersaturation or a catalytic speeding up of the reaction.

The use of the mechanical clarifier for presettling turbid water is a comparatively recent development. Four cities—Kansas City, St. Louis, Jefferson City, Mo., and Edmonton, Alberta—with a combined flow of 200 M.G.D. have adopted Dorr clarifiers for presettling, while St. Louis uses the clarifier for settling the chemically softened water as well. In none of these cases is operating data available at the present time.

Studies made at Jefferson City, Mo., in 1925 brought out on a semi-works scale the most important data bearing on presedimentation practice. Operating results (Table III) at Jefferson City during an 11-day run show the character of the results which should soon be obtained at the large installation referred to previously.

Presedimentation of turbid waters before chemical treatments results in a great saving in chemicals as the chemical dosage increases with the concentration of solids. Runs made at Jefferson City, treating the raw river water without presettling, showed that the coagulants required for clarification could be reduced to approximately one-half their former amount if the raw water were first presettled for three hours. Fleming, in a paper on Preliminary Sedimentation and Basin Detention at St. Louis, read in January, 1927, before the American Water Works Association, showed that his studies indicated an annual saving of $53,313 in iron sulfate and lime through subjecting 80 m.g.d. of Missouri River water to 3 hours presettling before the addition of chemicals.

The three flowsheets discussed in this paper are not to be construed as panaceas for all problems, for each problem is different from all others in a greater or lesser degree and must be approached from the professional angle as a separate and distinct one. Nevertheless the flow sheets presented do indicate the general features of plants having to contend with three frequently encountered water conditions and they do bring out the approved position of the mechanical clarifier with respect to other units in the layout.

The elimination of the difficulties inherent in the operation of intermittently cleaned settling tanks has undoubtedly been a forward step at many waterworks recently built or remodeled. The inevitable change in practice has had the cumulative effect of reducing the cost of producing a unit of potable water through continuous operation under uniform conditions which are conducive to simpler mechanical and chemical controls.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Table III—Presedimentation Tests at Jefferson City, Mo., July 15-18, 1926

Source of water supply	Missouri River
Average suspended solids in raw water	5,844 P.P.M.
Type and size presedimentation unit	Dorr clarifier 25 ft. dia. by 8 ft. deep
Detention provided in presedimentation unit	3 hours
Average suspended solids in overflow from presedimentation unit	417 P.P.M.
Average removal of suspended solids	92.8 per cent
Type and quantity of chemicals added to presettled water:	
Iron sulfate (average dose)	3.2 grains per gal.
Lime (average dose)	3.6 grains per gal.
Secondary sedimentation unit	15 ft. by 15 ft. plain basin
Average suspended solids in overflow from secondary sedimentation unit	36 P.P.M.
Average removal of suspended solids	91.5 per cent

Per Capita Water Consumption in Metropolitan District

The following tabulation for the annual report of Frank E. Merrill, Water Commissioner of the City of Somerville, Mass., shows the per capita water consumption in the Metropolitan Water District of Massachusetts for the year 1928.

	Total Per Day	Per Capita Per Day	Services Metered*
Milton	740,000	52	100
Medford	2,902,700	56	100
Stoneham	568,200	59	100
Arlington	1,717,500	62	100
Belmont	1,079,100	62	100
Winthrop	1,070,700	62	100
Revere	2,272,000	64	93.05
Malden	3,446,700	65	99.37
Melrose	1,420,000	67	100
Chelsea	3,618,700	74	100
Lexington	637,900	76	100
Swampscott	706,700	76	100
Quincy	5,195,600	78	96.45
Somerville	8,307,800	81	100
Watertown	2,229,600	81	100
Nahant	171,200	98	99.30
Everett	5,038,800	117	100
Boston	94,570,000	117	98
Total District	135,693,200	100	98 43

*Metropolitan District Commission Report for 1927.

Hot Water Melts Ice in Pueblo Streets

Hot water was used with considerable success this last winter by the city of Pueblo, Colo., for removing snow and ice from the streets, according to E. E. Colby, superintendent of parks and highways.

The Highway Department of Pueblo is troubled considerably with light snows which result, through the compacting of traffic, in the formation of a layer of ice upon the pavements and in the gutters. This is not only unsightly, but it also creates traffic hazards and impedes drainage. As removal with picks and bars has proved expensive and, at the best, unsatisfactory, it was decided to use the hot water from the condensers of the local ice plant to remove the ice from the streets.

The regular combination sprinkling and flushing unit—a 5-ton White truck equipped with 1,100-gal. tank and auxiliary pump motor—was used. The tanks were loaded at the plant in approximately 20 minutes and arrived at the job with the water at about 175 deg. The water was released slowly under low pressure and, with the assistance of a man with a bar, rapidly thawed the ice, which was carried into the sewers.

This was found to be a highly satisfactory method for disposing of the ice if the weather is not extremely cold. At very low temperatures, the water freezes, forming a light glaze of slippery ice which is as much of a danger to traffic as the heavy coating of ice disposed of through the sewers.

Progress of City Manager Plan

The Kentucky Court of Appeals, according to the Toledo City Journal, has held the city manager act in that state unconstitutional, because it was held to (1) violate a state constitutional provision that the mayor shall be the chief executive; (2) allow an authoritative position to be appointive rather than elective; (3) be faulty in its title. Three Kentucky cities, Lexington, Covington and Owensboro, had already voted to adopt the plan at the last November election.

Redwood City, Calif., recently adopted the city manager plan. The charter contains the rather striking provision that the manager must have previous training as a city manager, assistant, or deputy manager. A similar provision is contained in the proposed plan for New Rochelle, N. Y. The charter commission in St. Paul is considering the plan and officials and civic leaders in Omaha, Nebr., are considering its adoption. The plan was recently rejected in Lincoln, Nebr.; Sedalia, Mo.; Evansville, Ind., and Terre Haute, Ind.

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Man's Descent from a "Protoplasmic Globule"

In one of Gilbert and Sullivan's operettas a character says: "I can trace my ancestors to a protoplasmic globule." Said in jest, there may be truth in the statement. At any rate it is probable that evolution is a fact, and once we start to backtrack on that trail no end seems possible, save the "protoplasmic globule," and even that is not the end.

According to authorities on geology every geological era ended, and its succeeding era began, with an ice age. Every ice age had a profound effect on animal life, certain species vanishing and new species appearing. Huntington has suggested that man completed his evolution from the simian stage during the last ice age.

If we accept this hypothesis that animal evolution was greatly hastened by ice ages and other great climatic changes, and couple it with the hypothesis that climatic changes have been caused by great variation in sunspot activity, we reach this formula: No sunspots, no man; or at least no man in his present form.

Let us go a step farther in the analysis. Sunspots are great electromagnetic whirls, and the evidence is strong that they are generated by other electromagnetic fields, namely, those produced by the axial rotation of the electrified masses of planets and comets. Lying beyond the farthest known planet, Neptune, are comets, some of which have orbital periods that run into millions of years. Since all the superior planets have comets whose aphelia lie in the orbits of the planets, it is presumable that the converse is true and that at least some of the most remote comets are similarly associated with planets as yet unseen. Since it has been demonstrated that every one of the known eight planets produces a sunspot cycle, it follows that any trans-Neptunian planet probably produces sunspots, their number and size depending upon the strength of its electromagnetic field, the direction of its magnetic axis relative to the sun and the position of its magnetic poles. When the north pole of the sun points most nearly toward the earth, more pronounced barometric laws occur, indicating that anti-clockwise rotation of solar electrons probably causes release of more terrestrial electrons and certainly causes rising air whirls. Sunspots rotate and produce similar barometric effects. So we reach the conclusion that since sunspots produce cyclonic movements of terrestrial air, certain trans-Neptunian planets caused those great storm periods that we call geological ice ages.

This brings us abruptly to another formula: No electromagnetic whirls; no man.

Since the ultimate unit of electricity that accounts for magnetic effects is the electron, we conclude: No electron, no man; and by the same token, no electron, no "protoplasmic globule."

The World's Need of Researchers

Scientific research began scarcely more than three centuries ago, with Galileo, Kepler and Gilbert. Marvelous as its achievements have been, perhaps a greater marvel is that they are the accomplishment of relatively few men. It has been the custom to explain this fact by saying that genius is a rare gift. Yet, if the phenomenon is purely one of difference in mental power, and in the rarity of that supreme power called genius, how comes it that there were almost no scientific geniuses prior to about the year 1600? Scientific genius did not suddenly evolve at that time in a few humans. We must therefore infer that men had not till then learned how systematically to interrogate Nature so as to secure definite answers to their questions.

Although this explains, in a general way, the birth of modern research, still it leaves unexplained the fewness of researchers. Even yet their number is pitifully few when contrasted either with the total population or with the economic needs of that population. Doubtless much of the reason for so little researching springs from general ignorance of the nature of research. This ignorance has served to cast a screen of mystery about the art, leading to the belief that only a few divinely gifted mortals can successfully penetrate the winding labyrinths that lead to Nature's holy of holies.

Germany has done more than any other nation to dispel this particular delusion. By training thousands of young men in research methods, German universities have proved that research ability is by no means rare. But, even in the face of such proof, America has been exceedingly slow in entering upon a career of scientific research. Most of us still regard successful research as a thing unteachable, and confined to a gifted few who will somehow or other develop their native talents even in the face of public indifference and in the absence of pecuniary support.

This last clause gives the clue to much of the apathy toward research by men capable of research. The spirit of martyrs is usually found only where public applause accompanies self sacrifice. Many a man will bravely hurl himself into any breach if he knows that his bravery will be appreciated by his fellow men. But when self-sacrifice brings not even a murmur of approval, it becomes a rare thing. The self-sacrifice of the scientific researcher is of this latter sort. He would starve in a garret if assured glory were the reward; but almost the only reward for his research work is apt to be his daily wage, for his renown will probably not extend beyond the ranks of the very few of his own scientific class who are capable of appreciating his achievement. The wonder is that these few are not fewer.

Up to very recently scientific research was almost

entirely in the hands of a few college professors. Small as the salaries of such men have been, still the income served to maintain them, and their daily duties were such as to leave some freedom for investigating natural causes and effects. If even such scant support has served to develop a body of researchers whose achievements have already revolutionized industry, imagine what might have happened in the past three centuries had the same support been provided for ten times their number.

We venture to say that not a single one of the major death-dealing diseases would remain unconquered had ten times as many biological researchers been engaged in seeking causes and cures. We are so sure that successful research is teachable, and that native research ability is not rare, that we regard it as certain that multiplying the number of trained researchers by ten would multiply the discoveries by ten. Indeed, we may safely go much farther, for each discovery itself throws light on other research problems. Hence discoveries tend to multiply in a sort of geometric progression. This is one of the reasons for the startlingly rapid advance of science within the last generation. Another reason is the pecuniary support of research laboratories by many industrial corporations. At last "big business" has begun to see that behind the inventor is the research scientist who furnishes him with his basic ideas; and that behind both inventor and scientist there must be dollars if the combined achievements of these two groups are to be rapid and great.

Take the element of time. Where Goodyear labored the better part of a lifetime to learn how to vulcanize rubber, a great modern chemical research laboratory would probably accomplish the result in a year. In the place of one Goodyear there would be a score of chemists. In the place of his kitchen chairs and tables, burned in that last fine frenzy to keep the rubber in the pot boiling while he added sulphur, there would have been exhaustless fuel.

All honor to Goodyear the Gritty, to Goodyear the Great! But where is there any honor for his blind contemporaries? Neither praise nor pay did they give him, but left him to fight his research battle alone. Does this indicate at that time a public ignorance almost barbaric? It does, and scarcely less is the ignorance of the public of today. Scourged by diseases, poverty stricken as to nine-tenths of this globe, the world is still so ignorant of what research science could do to remove these blights on health and happiness that it looks with bovine eyes at its ills and never dreams that cures are to be had. Its suffering is pitiful; its ignorance is appalling.

Tornadoes and Sunspots

The Pasadena Post recently said: "Never before have the papers of this country had to record such a series of disasters due to tornadoes as have marked the present seasons. Day after day additions have had to be made to a somber list already large beyond known precedent."

The tornado is a belt of air whirling with great velocity, and in the northern hemisphere its direction of whirl is always anticlockwise, whereas in the southern hemisphere its whirl is clockwise. As to the direction of whirl it resembles the ordinary cyclone storm that originates in the Pacific Ocean and sweeps across our continent, but the velocity of whirl is much greater in the tornado. The tornado is short lived, an hour or so, whereas the cyclonic storm often lasts a week or more. The centers of both travel eastward.

Closely allied to the tornado is the tropical hurricane. The latter is, in fact, a giant tornado whose wind velocities are not so great as those of the tornado, but whose area is vastly greater. Hurricanes move westward before they turn eastward, their paths often being almost perfect parabolas.

The following table, compiled by Wolf and quoted by Huntington in "Earth and Sun," shows how hurricanes increase in number as sunspots increase.

Number of Sunspots	Number of Hurricanes
88	8
70	5
62	4
59	3
17	1 to 2

This table gives the number of hurricanes per year, with the corresponding monthly average of sunspot numbers.

Huntington also found that during the spring months hurricanes were 69 per cent more numerous when the average number of sunspots exceeded 80 than when they were fewer than 40.

Cyclonic storms are also most numerous when sunspots are most numerous.

Since tornadoes are clearly of the same nature as cyclonic storms and hurricanes, it follows that they should be most numerous at times of sunspot maxima. Since a sunspot maximum due to the planet Juipter was due about the first of November, 1928, it was to be inferred that the spring of 1929 would be marked by many tornadoes. This inference has been verified, an unusually stormy fall and winter in northern latitudes having been followed by an exceptionally large number of tornadoes in somewhat lower latitudes.

The sunspot cycle due to Jupiter reaches a maximum every 11.2 years, unless some more electromagnetically powerful planet submerges the Jupiter effect. Uranus has caused such a submergence at times. The next sunspot maximum assignable to Uranus will occur in 1951, just six months after a Jupiter sunspot maximum; hence it is probable that an exceptionally severe period of storms will reach a climax in 1951.

From now on the Jupiter sunspot period will slowly wane. Its next maximum will occur eleven years hence, in 1940.

According to Encyclopedia Britannica, Lloyd's has found that ship casualties are 18 per cent more numerous during the two years near sunspot maxima than during the two years near sunspot minima. Although this marine insurer has based rates upon such a relationship between sunspots and storminess, still there are meteorologists and astronomers who express skepticim about sunspots as a cause of storms. Perhaps there is a difference in carefulness of investigation when you back your conclusions with your money.

H. P. Gillette

The Chlorine Institute Standard Valve for Compressed Gas, Cylinders and Drums

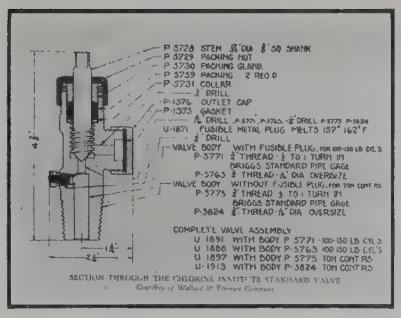
One of the finest examples of co-operation in the cause of public health between manufacturers of water works equipment and health and water works officials is in the development of the new Chlorine Institute Standard Tank Valve for chlorine cylinders and drums.

Although water works officials had for years, on frequent occasions, experienced delays and inconveniences due to receipt of a shipment of chlorine gas cylinders requiring yoke connections for auxiliary valves when fittings on hand were for the union type of attachment and vice versa. It required an emergency situation developed in the course of relief work following the Florida hurricane of 1926 to bring the seriousness of the then existing practice to a head.

The incident in point occurred at Hollywood, Fla., in September, 1926, when a shipment of several cylinders of chlorine gas delivered for emergency chlorination of water supplies could not be used because the cylinders required yoke type fittings while only the union type connections were on hand.

At a special meeting of the Public Health Engineering Section of the American Public Health Association on Oct. 13, 1926, at Buffalo, experiences in emergency chlorination of public water supplies following the Florida hurricane were the subject of a very interesting discussion. Before the close of the meeting the following motion was made by V. M. Ehlers of Texas, duly seconded and carried unanimously: "Moved that the secretary communicate with the Chlorine Institute and also the American Water Works Association with reference to the standardization of tank valves on chlorine cylinders."

Chlorine Institute Standard Valve with W & T Union Type Auxiliary Valve



Section Through Chlorine Institute Standard Valve

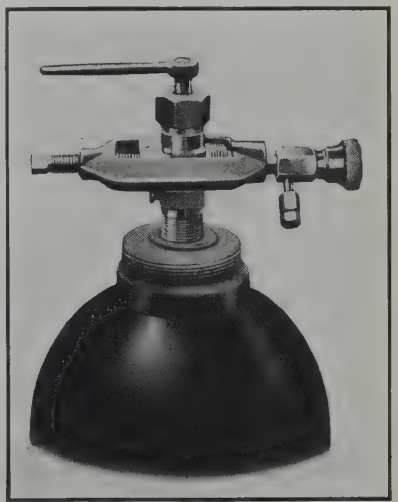
On receipt of communication from Arthur E. Gorman, secretary of the Public Health Engineering Section, referring to this action of the section and requesting its serious consideration by the Chlorine Institute, the directors of this organization at a meeting on Dec. 16, 1926, forwarded the communication to a special technical committee for investigation. This committee after very careful survey of conditions and a study of all types of valves, designed an entirely new valve adaptable for both union and yoke type connections which was accepted is now being manufactured. It is known as the Chlorine Institute Valve.

Investigations of this committee showed that but a relatively small percentage of the chlorine valves owned by manufacturers in the chlorine industry were used in the sanitary field. Also that the investment in these valves was a substantial one making their discards for new valves an expensive matter. However, in view of the health aspects of the situation the manufacturers decided on a policy of purchasing Chlorine Institute tank valves for the replacement of all discarded valves in use. The replacement by new valves was then confined entirely to containers used in the sanitary field.

It was estimated that this procedure would over a period of a few years permit the replacement of all valves used in the sanitary departments of their business with the new Chlorine Institute Tank Valve. It is estimated that to date there are approximately 25,000 of the new type valves in use.

They are being manufactured exclusively by the Wallace & Tiernan Co. and users report very satisfactory results with them. The new valve incorporates the best features of all valves in service. Among the features of the valve are a one piece genuine Monel metal stem, a brass forged body with 3/16 in. seat opening for the cylinder valve, and ¼ in. seat opening for the ton drum valve, an extra long and over size shank thread which allows for wear of the thread in the cylinders and gives increased length of life of the body, brass packing nut, gland and ring, so arranged as to permit packing the valve while in service, the use of soft packing, and the use of a removable bronze fusible metal container plug. The fusible metal represents the result of very extensive research work carried on by the members of the Institute. The outlet connection has the ¾ in. external straight pipe thread, which has been used in the industry for years, to accommodate a union connection and is also equipped with a recessed gasket surface to accommodate the use of an adapter and yoke. The packing nut takes the same wrench as the outlet cap.

The water works and public health professions and the members of the Chlorine Institute are to be congratulated for handling this important situation in such a business like and cooperative way. It is another indication of the fine spirit which exists in American industry in regard to public welfare.



Chlorine Institute Standard Valve with W & T Yoke Type Auxiliary Valve and Yoke

High Curbs on Toronto Bridge Promote Pedestrian Safety

Curbs on the new steel arch bridge carrying North Glen Road over the Park Drive ravine in Toronto, Ont., were made 15 in. high to assist in preventing motor traffic from mounting to the sidewalks. Regular 6x6-in. curbs are provided at the bases of the high curbs to prevent the scraping of automobile hub caps on the walls of the high curbs.

Green Sidewalks for New Orleans

New Orleans, it is stated, is soon to have colored sidewalks. The commission council has approved the paving of the sidewalks of Baronne St., from Howard Ave. to Canal St., with light green cement. This will eliminate to some extent the glare from the strong sunlight.

A New Chlorine Colorimeter

A new piece of equipment, known as the LaMotte chlorine colorimeter, for determining free or residual chlorine in drinking water, has recently been developed by the LaMotte Chemical Products Co., Baltimore, Md. The set

LaMotte Chlorine Colorimeter

consists of 8 permanent chlorine color standards in LaMotte "Sealed Nessler tubes" with polished tops and bottoms, representing 0.02, 0.04, 0.06. 0.08, 0.10, 0.15, 0.20 and 0.30 parts per million of chlorine respectively; three open Nessler tubes for the test sample; a 50 cc. bottle of Ortho Tolidine reagent with 0.5 cc. pipette and nipple; and a LaMotte Colorimeter for Nessler tube comparison. All this equipment is compactly arranged in a polished wooden case with a sturdy handle for carrying.

Previously great difficulty has been experienced with standards kept in open Nessler tubes, due to contamination from cork and rubber stoppers, and both contamination and loss of material if the solutions are kept in bottles and poured into the tubes when determinations are made. To eliminate these difficulties, all standards, including those for color, nitrogen, chlorine, iron, nitrate, etc., are put up in closed Nessler tubes with polished tops and bottoms, as recommended by F. R. Georgia (J. A. W. W. Assoc., May, 1926). The standard tubes are filled thorugh side arms which are then sealed off, preserving the standards from contamination of any kind. The special colorimeter must be used in making determinations with these sealed standards.

In making the determination, one of the open Nessler tubes is filled to the mark (50 cc.) with the water to be tested, 0.5 cc. of the Ortho Tolidine reagent added by means of the pipette, the tube shaken to ensure thorough mixing, and placed in the middle hole of the colorimeter.

Two consecutive color standards, for example, those representing 0.04 and 0.06 ppm. are then placed in the remaining two holes on either side of the test sample. The tops of the tubes are held toward a window or other source of daylight, and the standards changed if necessary, until the color of the reflection of the test sample in the mirror either matches that of the reflection of one of the standards or lies between the two. If an exact match is obtained the chlorine concentration in parts per million is read off directly from the standard with which the match is obtained. If the color lies between those of the standards on either side, the reading is taken as the average of the two. Thus if it lies between 0.04 and 0.06, it is taken as 0.05 ppm.

This set is also supplied with permanent standards and reagents for determining Nitrogen, Nitrates, Nitrites, Total Iron, Manganese, etc.

The new principle of making determinations by matching the reflection in the mirror, instead of by looking down through the tubes makes the readings much more simple and accurate.

Worthington Compressors Timken Equipped

A new line of compressors, employing Timken roller bearings on the main crank shaft journals, is announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. This is the Worthington single horizontal straight line series, so popular among smaller users of compressed air. Capacities range from 100 to 300 cu. ft. per minute and, operating at moderate speeds, maintenance charges and attention are said to be almost completely eliminated.

Oil rings, which deflect the surplus oil and return it to the crank case, are mounted on the shaft beyond the Timken bearings. A special feature is the design of the crankcase enclosure. This is completely oil tight, and free from oil leaks usually found in equipment of this kind.

"Feather Valves" are standard equipment on these machines, as they are on all Worthington air and gas compressors. These valves are light strips of steel, approximately 1/32 inch thick, which flex when opening against a curved guard to permit the passage of air. They probably are the lightest and simplest air valves in use.

Regulation may be by an automatic starter and pressure switch mounted on the motor, stopping and starting it to control the air pressure between definite limits. Or a pressure regulator may be attached to the compressor inlet valves, holding them open to maintain constant air pressure. Compressors with the latter type of unloader, which bypasses the air back to suction, are claimed never to overheat when unloading.

These compressors can be furnished with ball bearing idlers for short belt drive; with Texrope drives, using V-type ropes; or a synchronous motor may be directly mounted on the compressor crank shaft, thus eliminating transmission mechanism.

Witt Concealed Garbage Can

The Witt Cornice Company have brought out their new product the Witt concealed or underground garbage can.

This modern container for the underground disposal of garbage is quickly and easily installed without expense. It is out of sight, sanitary, odorless, cannot be upset and its contents will not freeze in winter nor ferment in summer.

The complete assembly consists of (1) semi-steel durable top fitted on (2) a heavy gauge, hot-dip galvanized receptacle which contains (3) a heavy gauge corrugated, hot-dip galvanized Witt garbage can or (4) a lighter gauge corrugated, hot-dip galvanized Brighton garbage can.

After each Witt concealed can is entirely finished in the black, it is hot-dipped in pure, molten zinc. The zinc (galvanizing) knits itself into the pores of the steel and will not crack, peel or chip. It averages 4¾ oz. per square foot and furnishes the rust-resisting quality so necessary for the long life of an underground can. At the same time it seals all cracks and crevices so that each inside can is water and odor tight. Unlike paint or other covering materials, this galvanizing coating becomes a part of the metal itself. Natural underground forces rapidly corrode ordinary metals. It is therefore of primary importance that cans made for such use be of rust-resisting quality.

New Stearns Conveyor System

The Stearns Conveyor Company, of Cleveland, O., a subsidiary of Chain Belt Company, of Milwaukee, Wis., recently completed a new installation at Evanston, Ill., of a coal handling system for the pumping station.

The coal is delivered by trucks, dumped into the receiving hopper from the bottom of which a reciprocating feeder delivers it to a gravity discharge conveyor which elevates it to the upper part of the silos. In one of the silos a steel cone is suspended, this design is patented. The cone and the upper part of the silo form a live storage space from which coal is drawn through a spout from the apex of the cone into a weight carrying car traveling in front of the boilers. When the live storage space is filled the coal delivered thereafter falls through the overflow spouts to the reserve storage space.

Correction

In the June issue reference was made to the A. M. Byers Co. of Birmingham, Ala. This should have been A. M. Byers Co., of Pittsburgh, Pa. The Byers Co. has been identified with Pittsburgh industry for sixty-five years.

Municipal News and Water Works

Vol. LXXVI AUGUST, 1929 No. 8

Steel Tanks for Water Works Systems

Probable Trend in Development of These Structures

By GEORGE T. HORTON
President, Chicago Bridge & Iron Works

One Million Five Hundred Thousand-Gallon Elevated Tank Built for Royal Oak, Mich. It is Part of the Woodward Ave. Water System Project Serving a Large Section of the Detroit Metropolitan District

IN 1893 there was illustrated in the engineering press the design of a hemispherical bottom elevated steel tank built at Laredo, Tex. This structure was designed by Mr. Edward Flad, consulting engineer of St. Louis. Mr. Flad has told me that this design was entirely original. To him, therefore, should be accorded all credit for the original conception of a steel tank with a suspended bottom.

Interested as I then was in the construction of steel standpipes and in steel towers for the support of wood tanks, I could quickly grasp the possibilities in a combination of the two. It did not require any very profound calculations to show that if the upper part of the standpipe, which provides the only effective storage, could be supported on a steel tower it could be done at far less expense than that necessitated by building the standpipe down to the ground and providing the necessary foundations.

Construction in the decade following the year 1895 was in a transition stage. The elevated tank immediately appealed to some engineers; others insisted upon wood tanks; many would have nothing but a standpipe. Old records will show numerous examples of standpipes built only 10, 12, and 14 ft. in diameter, over 100 ft. high, for which was paid more than elevated tanks of approximately double the effective capacity would have cost.

Arguments as to the relative merits of elevated tanks and standpipes no longer exist. Decision is now reached upon the engineering opinion as to the best and most economical method of obtaining the desired storage.

Most Economical Form.—The most economical form of a simple storage tank—by which I mean a tank supported directly upon the ground or upon foundations if necessary—is one in which the height and diameter are approximately the same; provided the height does not exceed 50 ft. If a greater capacity is desired than can be contained in a tank 50 ft. in diameter and 50 ft. high, then the diameter only should be increased to obtain the desired capacity.

This, to be sure, is only a general statement, subject to several variable factors such as thickness of bottom and roof, allowed unit stresses, and cost of foundations.

The oil industry presents the greatest demand for storage tanks. Quite elaborate studies in connection therewith indicate the most economical height to be from 46 ft. to 48 ft. These tanks are universally built directly upon the ground, the only foundation work usually done being the removal of the top soil and leveling of the exposed surface.

I think it not amiss to call to your attention this fact, that most of the storage tanks of the world are built with so little foundation work, and that I see no reason for the construction of such extensive foundations as are usually placed under water tanks.

Elevated steel tanks of earlier years were practically all built with hemispherical bottoms. A few conical bottoms were tried out and discarded except in special instances, the most notable being those for railroad service.

One Million-Gallon Elevated Tank at Springfield, Ill. It is 72 Ft. in Diameter, Has a 17-Ft. Shell Height and a Total Range in Head of Only 37 Ft. 8 In.

The Ellipsoidal Bottom.—As demands for ever increasing capacities developed, certain inherent difficulties in the hemispherical bottom tank appeared. If we endeavored to limit the total height of a tank in order to prevent an undesirable range of head, the diameter would become so great that the bottom would be out of all proportion to the cylindrical part of the tank: for example—should be called upon for a hemispherical bottom tank containing 1,000,000 gal. and having a total height of 40 ft., the tank would be all bottom; because 1,000,000 gal. is the capacity of a hemisphere 80 ft. in diameter. The same condition would prevail in an effort to store 2,000,000 gal. within 50 ft. We obviated these difficulties, in part, by making an ellipsoidal bottom, the vertical depth of which is but half that of the hemisphere.

An ellipsoidal bottom tank answers very well in capacities up to 500,000 gal., constitutes an improvement in all sizes, and is the explanation of why so many of our large tanks have been so built. Unfortunately some of the stresses in an ellipsoidal bottom are compressive rather than tensile. These

compressive stresses in tanks of over 1,000,000 gal. capacity are of sufficient magnitude to necessitate an increase in the depth of the bottom, causing an increase in the range of head, and thus setting up a vicious cycle. More simply stated—when there is a limit to the total height of a tank, there is also a limit to the size of that tank if it be of the suspended bottom type.

It is not practical to build a hemispherical bottom tank containing more than 175,000 gallons, nor an ellipsoidal bottom with more than 300,000 gallons, the total height in each case being limited to 25 ft. While we have not as yet been called upon to build many tanks so limited, it is not unlikely that the future will bring such calls.

Advantage of Elevated Storage for Larger Systems.—Only recently have those advantages of elevated storage, known to obtain in a small plant, been considered applicable to our larger systems. (Witness the paper on this subject presented by Nicholas S. Hill at the Buffalo meeting of this association; also one presented to the Rocky Mountain Section by Donald H. Maxwell, of the firm of Alvord, Burdick and Howson; as well as many actual installations, such as those at Detroit, Charleston, San Antonio, Tampa, and others.) I am told that for such service the less the variation in head the better. Theoretically, the maximum head should also be the minimum; or perhaps better stated, the minimum head required should also be the maximum.

Pumps operate at their highest efficiency against a constant head. Pumping against additional head involves useless expenditure of energy; and where power is purchased, easily reducible to exact figures.

These conditions show that in determining the proportions of a tank, operating costs should be considered. In any city where elevated storage is under consideration, certain practical problems are at once presented to the engineer in charge. Studies must be made to determine to what extent it may be economical to limit the range of head. Once that limit has been fixed, there arises the question as to whether the storage will be better provided by the installation of many small tanks, or by fewer large ones. Very likely it will be found that the larger units are preferable; furthermore, that the size of these units will exceed the limit of any possible suspended bottom tank.

Suspended Bottom Tanks.—I imagine that there is prevalent an impression that a suspended bottom tank is the only practical—at least the most economical—form. For many years I so believed. This impression is true as regards all ordinary sizes. It is also true if the height of a tank be unlimited. Not otherwise.

The fundamental economies in suspended bottoms obtain by making use of the inherent strength in the bottom plating, and in lesser degree to the fact that a hemisphere or ellipsoid requires the least surface to contain a given volume.

The suspended bottom, due to the refinements required in its construction, is the most expensive part of a tank, and as its size is increased greater stresses necessitate heavier material. It is evident, therefore, that a point will be reached at which the additional material required in a suspended bottom will more than offset the cost of beams and girders necessary to support a flat bottom. At this point the economies in a suspended bottom tank disappear.

I have recently studied this subject sufficiently to announce that tanks over 1,000,000 gal. in capacity may be built with flat, or approximately flat, bottoms which will cost less than tanks of the same capacity with suspended bottoms. Stated more specifically, and of course referring to equal capacities, I am sure that an elevated tank with an approximately flat bottom, the height of which will not exceed 25 ft., can be built for less than can an elevated tank with suspended bottom, the total height of which will be more than 50 ft. I presume you understand that my references to the height of a tank apply to the tank only, and not to the height of the supporting tower.

There is seemingly a growing demand for tanks limited in height in order that the range of pressure may be reduced. I know of two tanks built during the past year—each 1,000,000 gal. capacity, one of which is only 8 ft. high, and the other 24 ft.; both so constructed for the reasons cited.

I think this discovery, viz., that we may radically change the form of our larger tanks from that heretofore used, to one which will reduce operating charges and at the same time effect an actual first cost saving, is most important. It will, I hope, prove of practical benefit to those members of this association who have before them the problem of elevated storage.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association at Toronto, Ont., June, 1929.

New Industrial Water Rate at Fort Worth, Tex.—A new industrial rate on water was authorized in July by the Fort Worth City Council. It is for consumers "with a weighted average of 4,000,000 cu. ft. or 30,000,000 gal. per month," and on this basis will cost 12½ ct. per 1,000 gal. The table for the ordinance to be drawn covering the new schedules: For the first 350 cu. ft. $1, next 24,650 cu. ft. 22½ ct., next 25,000 cu. ft. 17½ ct., next 1,374,575 cu. ft. 12½ ct., next 2,575,425 cu. ft. 7½ ct., all over 4,000,000 cu. ft. .934 ct.

Sanitation of Automobile Tourist Camps

The safeguarding of the health o automobile tourists, both on the road and in the camps, has become an im portant public health problem. As earl as 1925 it was estimated that in 3 states there were more than 3,00 camps attended by over 2,000,00 campers. In 1928, it was estimate that, in California alone, there wer 1,400 automobile camps. In othe states, particularly those with well ad vertised scenic areas, there were prob ably several thousand others. Invest ment in camps of all kinds in the stat of Maine has been estimated to excee $5,000,000. Much has been done withi recent years to improve tourist camps but there is yet much more to do. Fo example, in one state in 1926, ther were 233 camps inspected, and only 10 of these could be approved.

The problem is not a simple one bu involves three important factors: First an intelligent understanding of th situation by the people; second, the co operation of state and local authorities and the support of official and volun tary organizations; and, third, the mos important, the fixing of the responsi bility for the maintenance of sanitary conditions.

In many states the responsibility fo the sanitation of tourist camps ha been delegated to state health officer by law, and in others, those agencie have undertaken it without expres authority. In a few states where th state agency is doing the work, part o all of the authority has been trans ferred to district or local agencies o groups. Unfortunately, there are a few sections in which the responsibilit for the work has not been positively assumed by any particular departmen or group. However, these sections ar in the minority, because within the las few years much careful thought an diligent effort has been given by healt authorities as a whole to making living conditions for campers as nearly suit able for them as possible.

Such state agencies as have started tourist camp sanitation work have usually set up regulations governing the proper construction and main tenance of this kind of camp. The three principal items in any set o regulations might be given as follows: (1) Proper camp location; (2) Safe and adequate water supply; and (3) Safe and efficient waste disposal.

What is the effect of location on a tourist camp-ground? This question might be sub-divided as follows: (1) Is the site of ample size? (2) Is it provided with a reasonable amount of shade and natural shelter? (3) Will the soil readily absorb and remove water? (4) Is the site accessible to the tourist? (5) Are utilities available from the city, and, if not, are conditions such as to permit the installation of the necessary facilities?

Latest Developments in Asphalt Paving Practice

Subgrades—Base—and Wearing Surface

By HUGH W. SKIDMORE
Of Chicago Paving Laboratory, Inc., and Craig, Skidmore & O'Brien, Inc., Chicago

A DISCUSSION of this subject should not be confined to asphalt wearing courses, because an asphalt pavement, in common with all others, must have an adequate base which in turn superimposes a subgrade, good, bad or indifferent. Bases may be of several distinctly different types structurally and likewise subgrades may, and frequently do, vary greatly within the limits of a given project. Thus we find our discussion encompassing developments in base practice and subgrade classification and treatment.

Subgrade.—Fundamentally the subgrade should be considered before the base and surfacing are designed, because the nature and bearing capacity of the soil may control the choice of both base and surfacing. Poor subgrade may respond to drainage or treatment readily and cheaply so that it will be the equal of good subgrade, or it may require such extensive treatment as to warrant spending more on the pavement and little or nothing on the subgrade. However, reasonably good subgrade support is so basic as to render doubtful its neglect in favor of expensive pavement in the vast majority of cases. There is even some doubt as to whether it should ever be neglected in the light of expensive maintenance and reconstruction in years to come. In any event, subgrade is so important that every operation depends upon its character.

One large project recently investigated, included a variety of conditions none of which has been taken into account in designing the pavement. Both top and base had followed arbitrary standards of thickness and mixture that were quite satisfactory where drainage was good and subgrade support ample, but failed miserably when conditions changed suddenly within the project.

When the Drainage Was Neglected.—A considerable cut was made at the top of a hill adjoined by a heavy fill diminishing to zero in a few hundred feet, from which point on for a mile or more the street passed through a very flat, poorly drained section in which water stands in great ponds during the spring and fall seasons. The pavement is not on a fill through this section, which means that the concrete base is saturated a great portion, if not all, of the time and especially during freezing weather. Hence in a period of only a few years, the base has failed in the cut from lack of proper intercepting drainage, on the fill from settlement, and in the flat section from disintegration of concrete due to freezing of saturated base. Cores taken from this project, together with a careful study of subgrade conditions, prove conclusively what has happened. At no point has the sheet asphalt top failed except as it has finally followed the broken or settled concrete base. Thus an asplant pavement has failed through no fault of the asphalt and a concrete base has failed because its subgrade support was not uniform in one case and in the other because it was saturated.

Obviously drainage would have eliminated this extensive failure except that caused by fill settlement, in which case the fill was too new at the time of construction. No pavement of economical design is capable of withstanding such extremely adverse conditions.

Classification of Soils.—Recent developments in subgrade investigations and soil studies have provided comparatively simple means of classifying soils with respect to bearing power and drainageability together with various means of subgrade treatment such as:

1. Porous layers on certain soils.
2. Insulating layers of fine, granular materials to prevent soft soils from working up into macadam bases, or porous sub-bases.
3. Bituminous treatment to break up capilarity, and to prevent fine soils from working up into macadam bases.
4. Compacted layers of gravel, stone, slag, etc., to correct lack of uniformity of subgrade support.
5. Drainage to remove moisture from wet areas, and to prevent wetness by intercepting flow from water-bearing strata.

Research work now in progress promises to develop much more valuable knowledge of subgrade performance.*

Base.—Pavement bases must transmit loads to a subgrade. The subgrade is essential and must finally carry the entire load of traffic. In the subgrade is good and of high supporting capacity, the base or foundation course may distribute the load over a comparatively small area without danger of rupture of the pavement base or surfacing. As the load bearing capacity of the subgrade diminishes or traffic loads increase, the foundation must distribute load over a greater area in order to avoid base failures. This becomes true, however, only when the danger point is approached, and is not an arbitrary rule, but is entirely relative to the actual capacity of the subgrade and traffic loads.

As has been shown above, correction of defective subgrade is basic, and should be abandoned only after most careful diagnosis, if at all. But even fairly good subgrades differ in capacity, so that arbitrary laws governing base type and thickness for a given traffic load cannot be laid down. Thus a thin 3-in. or 4-in. base may be ample for one subgrade, while a 5-in. or 6-in. might be required for another, etc. Likewise a macadam base may be entirely ample for one subgrade and entirely inadequately for another unless subgrade is artificially stabilized or base thickness is increased beyond possibly an economical limit.

Old Roadbeds as Foundations.—Traffic bound bases, such as old roadbeds, are nearly always excellent foundations for two very substantial reasons; they are thoroughly compacted and free from further settlement, and they are capable of carrying the traffic even though they may fail or have passed their useful period as wearing surfaces. It is because of these important economic reasons that resurfacing has become so popular. It has thoroughly demonstrated the folly of destroying a present investment for a new one of doubtful economy. Likewise stage construction, or progressive development of pavement commensurate with present needs while simultaneously laying in a store of valuable assets in the nature of future base for a surface of the first order when such shall be required, is constantly impressing more and more engineers with its soundness. Wide awake municipal engineers have recognized the economy of such development for many years, but are frequently prevented from utilizing it because of legal difficulties attending special assessment work. Several eastern states have employed it with outstanding success, likewise the state of Michigan is doing the same thing in connection with gravel and macadam roads.

Such construction marks one of the greatest of recent developments in asphalt paving practice and affords one of the most fertile fields for further progress.

Black Base.—Black base cannot be properly called a recent development; it is actually one of the oldest types of base in the country. However, in its present advanced state, it can be called one of the most important developments

*Reference is made to the valuable discussion of this subject by C. A. Hogentogler, in Proceedings of American Road Builders, 1929, and the May issue of "Public Roads."

in recent asphalt paving practice. Having been a close student of this type of construction for many years, I do not know of a single instance where it has failed of performance and that is something which cannot be said of any other type of base. True, it should not be employed in utter disregard of exact type (premixed, hot or cold, penetration, mixed-in-place, etc.) thickness, character of subgrade and drainage, but, taken "catch-as-catch-can," it has a remarkable record of performance.

Sometimes no base is required. Now and then cities find themselves the fortunate possessors of natural bases in subgrades of high supporting capacity such as gravel or sand. Where such conditions exist, advantage should be taken of these assets in designing pavement. There are numerous examples of asphalt wearing surfaces laid directly upon native subgrades of this class, which have given complete satisfaction for many years. I have in mind a certain section within the city of Joliet, Ill., where the asphalt surfacing is laid directly upon native gravel subgrade. These pavements have given excellent service for about 20 years.

Asphalt surfaces are a great protection to portland cement concrete slabs. This is perhaps the most outstanding fact developed by such experimental pavements as the Bates and Arlington Experimental Station Roads. Such surfaces protect their rigid bases against breaks following cracks in the concrete. They do not, however, prevent cracks and it is folly to expect no cracks in an asphalt pavement laid on concrete base. Soft asphalt and rich mixtures are no cure for this evil. Rich mix bases are likewise no insurance against cracking; on the contrary, tend to encourage it. Rich mix in bases is only justified in the case of persistently wet subgrades and even in these cases subgrade treatment and drainage nearly always proves to be more economical. It is well known that the richer mixes of concrete are more resistant to disintegration from freezing, hence will usually outlast very lean mixes on very wet subgrades.

One of the recent developments in asphalt paving that is increasing in great strides, is the resurfacing of badly worn and cracked portland cement concrete pavements. For this purpose, hot mix asphalt is proving to be the ideal material.

Another development in connection with concrete bases is machine finishing, leaving only a rough, grainy surface instead of the usual irregular surface. Machine finished base has the advantage of generally smoother asphalt surfaces. It is not advised, however, unless surface mixtures of good stability are laid after careful design. The city of St. Paul, Minn., has pioneered in this development with success.

Wearing Surfaces.—Undoubtedly the two outstanding developments in the field of asphalt paving mixtures are, first, rational mixture design from actual scientific basis instead of the old "cut and try" method and, secondly, the stability or shear test for rating mixtures according to traffic requirements. This test is of great value in investigation of failures, examination of materials, design of mixtures and control during construction.

Two stability tests are in use. One is the Hubbard-Field test which is adapted only to fine mixtures such as sheet asphalt. This test gives an empirical value which represents a combination of functions of the mixture under test. The other is our own test (Chicago Paving Laboratory) which measures the shearing strength of the mixture and is adaptable to all types of mixture regardless of size of aggregate.

Both tests are made at the same temperature, and for fine mixtures, upon cylinders of the same size. In our test, cylinders are increased in diameter and height as the aggregate increases in size. The Hubbard-Field results are not capable of reduction to unit stress, consequently are expressed in total load required to cause failure, hence must always refer to specimen of the same size. The Chicago Paving Laboratory shear test gives values of the basic stress that resists rutting and waving (distortion under traffic loads) and these are expressed in pounds per square inch. A fairly accurate conversion factor is possible between the two tests when applied to fine aggregate mixes such as sheet. Joint work between Messrs. Hubbard and Field and our laboratory shows that Hubbard-Field values are about 75 times ours for identical sheet mixtures.

For several years the need of a physical test for asphalt paving mixtures, capable of measuring resistance to displacement under traffic, has been badly needed. Several years' experience in both laboratory and field leaves no doubt as to the real practical value of these two tests. Since they have been in use, much valuable data has been developed concerning mixture performance. In every case of tests upon old mixtures that have given years of satisfactory service, we have found stabilities in line with those for which we are designing under similar traffic conditions today. For example, mixtures showing shear strength of 50 lb. per square inch, or better, are withstanding the dense, heavy traffic of Michigan Ave. in Chicago, whereas those showing only slightly less than this are rutting under the bus traffic.

Thus it is obvious that mixtures need not be designed in the hope that they will withstand the traffic but they may be so designed that they are certain to do so. The stability, or shear, test has done two important things that alone more than justify it as a practical test; it has exposed the fallacy and danger of attempting to increase stability by means of (a) using harder asphalt cement and (b) laying dry mixtures containing less bitumen than will comfortably fill the voids in the mineral aggregate. Extensive investigations show, first, that a 10 point drop in penetration will mean a gain of only about 5 lb. per square inch shear strength, whereas an increase of 3 per cent in raw filler, say from 15 to 20 per cent in terms of total mix, usually means at least doubling or trebling the shear strength; secondly, both decrease and increase of bitumen beyond a certain optimum amount causes a drastic falling off in stability. Hence by applying a scientifically correct test, it is easily proven that "guessing" and "hoping" for results may lead into dangerous ground—the most commonly used remedy for lack of proper stability not only failed to accomplish hoped for results, but actually harmed the mix.

Correct modern practice calls for two cardinal principles, use as much bitumen as the mixture will carry, and use a soft bitumen consistent with the traffic and actual stability afforded by the mixture. If greater stability is needed, this can readily be accomplished by manipulating the mineral aggregates, especially the filler which is the most important stabilizing factor. It is just plain ignorance to try to design an asphalt mixture around an arbitrary percentage of bitumen.

Thorough Mixing of Aggregates Important.—An important item in mixture preparation that was disclosed by the field investigations of Messrs. Hubbard and Field last summer, is the importance of thorough mixing of the aggregates before the asphalt cement is introduced. Uniformity of mixture depends upon about 30 seconds dry mix with an additional 15 to 30 seconds after adding the asphalt. The stability test proved invaluable in this investigation. The importance of such definite knowledge as this is obvious. Continued mixing at high temperature with the asphalt in thin films on the mineral, tends to harden it materially, in fact, decidedly dangerous hardening occurs of temperatures above a certain minimum, depending upon the asphalt used. Thorough dispersion of mineral once it is coated is not readily obtained, hence the importance of dry mixing with only such additional times as will accomplish thorough coating of mineral since that is all that is necessary. Thus it is seen that arbitrary long mixing periods may not only fail to accomplish the desired results but are actually dangerous.

Use of Machine Finishers.—The most recent development in the art of laying mixtures is the use of machine finishers similar to those used on portland cement concrete pavements. These machines, adapted to hot mix, have proven very successful on highway work, but as yet have not been worked out for city pavements where intersections and changing section introduces a problem. It is to be hoped that some type of me-

chanical finisher will be devised for use on city pavements.

The use of a lute on freshly raked mixture has now become almost universal, likewise the heavy three-wheeled roller for initial compression. All of these improvements not only affect quality of workmanship, but are the source of real economy.

Continued research investigations by leading technologists are not only substantiating many things that have been suspected, but are also bringing to light many new and important facts pertaining to the manufacture and laying of asphalt paving mixtures. The old order of "rule of thumb" procedure must give way to more modern scientifically correct and practically sound methods.

Acknowledgment.—The foregoing paper was presented June 26 before the Michigan Municipal League at Grand Rapids, Mich.

Problems of the Engineering Profession

Due to General Public Misconception of True Professional Status

By D. B. STEINMAN
Consulting Engineer, New York City

THE enginering profession is confronted with a number of problems arising from general public misconception of the true professional status of the engineer.

Improper Method of Engaging Engineering Service.—One of these problems is the persistence of public officials in following improper methods of selecting and engaging professional engineering services.

It is still regrettably common for municipalities or counties, contemplating some public work, to ask engineers, either by advertisement or by letter, to submit competitive bids for furnishing the required engineering services. Such procedure for engaging professional services is fundamentally wrong in principle. It virtually reduces the selection of an engineer to the basis of fee-competition. It hurts the profession by lowering its standards. It harms the public interest by placing a premium on cheapness of service rather than on high standards of professional qualifications.

Let us consider a parallel case. If you were in need of a surgeon to perform a critical operation, requiring specialized knowledge and skill, with perhaps a human life hanging on it, what course would you follow? You certainly would not ask different physicians to submit competitive bids for performing the required operation. You certainly would not go from door to door and engage the doctor who would quote you the lowest fee for the operation. You might find a raw medical graduate who would undertake the case without adequate compensation for the sake of the experience, but you certainly would not entrust it to him. On the contrary, you would seek the most expert suregeon, one of the highest standing and reputation in his field. The question of fee would be a secondary consideration. Where human life is at stake, you want the best professional services, not the cheapest.

Suppose you required legal services on matters involving millions of dollars, what procedure would you follow? Would you engage the cheapest lawyer you could find, or the best you could secure? You certainly would not call for competitive bids for the required legal services. You might secure an inexperienced or second-rate lawyer for a lower fee, but you would gladly pay the difference to retain the best legal counsel where large property interests are at stake.

Selection on Basis of Qualification.—The same principles should apply even more forcibly in the selection of professional engineers. Public officials seeking consulting engineers to design and supervise the construction of large public projects should regard it as a public trust reposed in them to select the most competent engineers on the basis of qualifications and experience, and not on a basis of fee competition. To the physician you entrust human life. To the lawyer you entrust property interests. To the engineer you entrust both: Upon his conscientious expertness and skill, the safety of both life and property are dependent.

Each profession has its standards of fees, based on the investment of training and experience and the cost of providing proper and adequate services. The engineering specialist has the same high investment of training and experience as the highest ranking physicians and lawyers. If engineers are induced to cut their standard fees by the pernicious custom of subjecting them to fee-competition, they cannot give the full measure of generous service and performance upon which the standard fees are based. The difference in fee is a mere trifle in comparison with the much larger savings which may be effected through the skill, knowledge, and efficiency of the expert professional engineer.

The custom of asking engineers to submit competitive bids for professional services probably arises from a confusion in the minds of public officials who do not distinguish between engineering and construction. The one is professional, the other is commercial. To the extent that construction work may be minutely and definitely specified, it is appropriate to select contractors by competitive bidding. But the planning, designing and specifying of the construction work represent professional services, involving the human equation, and themselves incapable of definite specifications. Two different engineers on like engagements will not give the same services, in kind or quantity. Professional work, whether law, medicine, or engineering, cannot properly be reduced to a basis of competitive fees.

The correct procedure for public officials, who wish to conserve the best interests of the communities they represent, is to ascertain through informed and impartial sources who are the best qualified engineers to handle the contemplated project. For this purpose, the National engineering organizations may be consulted. After the engineer or engineering firm is selected on the basis of such investigation or recommendations, then the amount of the fee can be arranged by mutual agreement or on the basis of published professional standards. Only by such procedure will the best interests of the public be served.

Free Engineering Service.—Another problem faced by professional engineers is the expectation or demand for free engineering services before a project is authorized or before an engineer is selected. This practice may take the form of asking engineers to make preliminary studies, surveys, estimates, and reports on a proposed undertaking, without compensation, but with the possibility of a professional engagement as a bait. Another form of this practice is the invitation addressed by public officials to engineers to submit free designs and estimates for a given project as a basis for awarding the professional engagement. Such practices are unfair, unsound, and contrary to public policy. It is an economic waste to multiply services on a given project. To base the selection of an engineer upon the comparison of uncompensated preliminary estimates places a premium upon the skimpiest design or the most elastic conscience. Such practice is conducive to subsequent disappointment or failure. Free service can hardly be expected to offer the requisite degree of thoroughness and reliability. Some one has to pay the freight. Professional men may be expected to give free services in charitable cases. But public communities and corporations can hardly be classed as charity cases. The laborer is worthy of his hire. If the services are worth anything, the engineer should not be asked to furnish them without compensation.

Instead of asking different engineers to gamble their time and money on making competitive designs and estimates, the public body should select an eminently qualified engineer in whom it has confidence, and pay him to make the alternative designs and studies of cost as a basis for any decisions and selections.

Public Fails to Give Engineer Credit.—A third problem confronting the engineering profession is a failure of the public to recognize the full scope of the qualifications and training of the engineer. On public boards, municipal councils, and planning commissions, the engineer is still generally conspicuous

by his absence. The public fails to realize that the modern engineer does not limit his work to surveying and drafting, or the computation of stresses and strains. By training and experience, and by force of the diversity and complexity of the problems he has to handle, the modern professional engineer is an expert on ecoonmics, financing, promotion, organization, and management. The modern engineer has to conceive large projects in their broadest aspects and in their most far-reaching ramifications. He has to investigate and demonstrate their economic soundness and financial feasibility. He has to organize, direct, and supervise the work of armies of men. He has to conceive, plan, and execute projects of largest magnitude. He has to exercise vision, resourcefulness, judgment and versatility beyond the requirements of any other profession.

With these qualifications, in addition to his knowledge and understanding of public improvements from the professional viewpoint, the engineer should be found in all important executive and administrative positions. The public cannot afford to have the engineer missing from public boards, councils and commissions.

Our profession has always pointed with pride to the early engineering career of Washington, and to the record of Lincoln as a land-surveyor. For the failure to elect more engineers to distinguished public office, we found gratifying consolation in the fact that two representatives of our profession had been Presidents of the United States, and that these two had been the greatest Presidents in the Nation's history. Now we can add a third name to the list, for in Hoover we have an exemplification of all that we mean today by the name engineer—a planner, an executive, an administrator. With the names of Washington, Lincoln and Hoover to inspire us, we may look forward to the day when engineers will be recognized and sought for all of the highest positions of leadership and trust throughout the land.

Acknowledgment.—The foregoing is an address delivered March 30 in the A.A.E. radio program from Station WNYC, New York City.

Latest Methods of Road Finance, Construction, and Administration Treated in New Booklet

A timely publication involving an extensive study on the subject, "Highway Construction, Administration, and Finance," is announced by the Highway Education Board, Architects Bldg., Washington, D. C.

It deals with the planning of a national highway system, with the various types of road suitable for differing traffic conditions, and with methods of financing such highway building. The studies are by E. W. James, Chief of the Division of Design, United States Bureau of Public Roads, and now on leave in Colombia assisting that South American government in organizing a road-building program. The booklet is printed in Spanish, Portuguese, and English.

"Poor roads," says Thomas H. MacDonald, chief of the United States Bureau of Public Roads, in an introduction, "cost more than do adequately serviceable roads. Roads built with honest administration and skilled technique have an earning capacity far beyond their cost. So the serviceable public highway has every right to be listed as an asset and not as an expense. It has already been well demonstrated that the highway can earn its upkeep, plus a very high profit on the investment.

"Road tolls collected in the form of motor vehicle license fees and gas taxes in the United States amount to a very large percentage of the annual highway bill, without excessive cost to the individual user. The very fact of relatively low taxes has encouraged the enormous use of the roads by so large a number of the public. This accounts for the high income from the roads in actual financial returns. It proves the value of good highways."

Recognizing that the financial problem involved in the highway program is in all countries "the fundamental and difficult one to solve," Mr. James points out that, in order to keep expenditures to a minimum, three things must be attempted:

1. To select the right roads to be improved;
2. To determine the correct types to build at any time; and
3. To build progressively, but so that all work done may be salvaged in future work.

The best method, he asserts, is "deliberately to plan a national highway system." It matters not, he adds, that pioneer roads and trails have developed, that some roads already have been improved, that cities have grown and the rural districts have been put under cultivation. Such study, he says, may disclose errors of the past and may lead to a change in location and priority of construction for many miles of highways, but if it does it saves money.

"Studies of highway systems made in the United States during the past three years," says Mr. James, "clearly demonstrate the value of such work even at a late date. But obviously the earlier in the highway history of a country such studies are made the greater good will flow from them."

The general character and condition of economic development, as revealed in data based on population, agricultural production in tonnage for general crops and in cost for special crops, such as dairy products delivered directly for consumption, and manufactured products by cost, must be surveyed, it is stated, in approaching a national or state highway plan. Other factors which must be considered include topography; existing traffic on the roads and the classification of this traffic; and the probable adequate mileage of roads in the system as a whole and in the several political or economic subdivisions thereof.

Emphasis is laid in the Highway Education Board's report on the importance of the progressive method of road building which, it is asserted, is "the only way possible to give service within any reasonable period to a state or nation which yet has most of its pioneer roads to improve."

As to financing it is declared that "roads should be built only to the extent and of such types as will pay for themselves." Every piece of construction, it is asserted, should be planned with an eye to the future and to the possibility, indeed to the probability, that a betterment of type will be required. Any highway expenditure to be justified must be earned by the road in the form of cheaper transportation, says the report, which argues that highways are fundamental requirements in a healthy, progressive, prosperous, and ambitious nation.

Fast Roads Proposed for Netherlands

The Nederlandsche Vereeniging voor Auto-Snelwegen (Netherland Association for Fast Motor Roads) is conducting an active campaign in the country for the building of through roads to be devoted exclusively to motor traffic, according to a report from Assistant Commercial Attache Paul S. Quinn, The Hague, released by the Bureau of Foreign and Domestic Commerce. Their plan is to build one road from Amsterdam, the capital and country's largest city, to Rotterdam and on the southern border leading into Belgium, another from The Hague through Utrecht to the eastern border leading into Germany, and to connect Amsterdam to the east-bound highway by a special connecting roadway between that city and Utrecht. According to present estimates the cost of this entire road plan would be around f. 200,000,000 ($80,400,000) and it is indicated that there is sufficient banking support to execute the scheme providing the Government will undertake to guarantee interest return on the investment.

The organization devoting itself to promotion of the proposed motor road plan is made up of a number of people interested in road problems including a representative from each Algemeene Nederlandsche Vielrijdersbend and Koninklijke Nederlandsche Automobielclub, two important associations devoted to automobile, traffic and roadway developments.

New Developments in Safeguarding and Eliminating Cross Connections

A Summary of New Developments in New York State

By C. A. HOLMQUIST and EARL DEVENDORF
Director and Associate Director, Division of Sanitation, New York State Department of Health

THE subject of cross-connections between public water supply systems and auxiliary industrial and fire supply systems from various polluted sources, has been much discussed and written about by leading water works and public health authorities throughout the past decade. Not alone in New York State but throughout the United States, there have been numerous occurrences of waterborne outbreaks of disease, attributed to polluted water entering the public water supply systems through various types of cross-connections.

The New York Regulations of 1925.—The Public Health Council of the State of New York after a prolonged and deliberate study of the problem of cross-connections between potable and non-potable water supplies, enacted, in November, 1925, the following regulations, known as Regulations 15-a and 15-b of Chapter VII of the Sanitary Code, requiring by July 1, 1928, the elimination of such cross-connections in New York state:

"Regulation 15-a. Certain cross-connections between water supplies not permitted. No officer, board, corporation or other person or group of persons, owning or having the management or control of any potable water supply furnished to any municipality or water district, shall permit after July 1, 1926, any physical connection between the distribution system of such supply and that of any other water supply, unless such other water supply is regularly examined as to its quality by those in charge of the potable water supply to which the connection is made and is also found to be potable. This prohibition shall apply to all water distribution systems either inside or outside of any building or buildings.

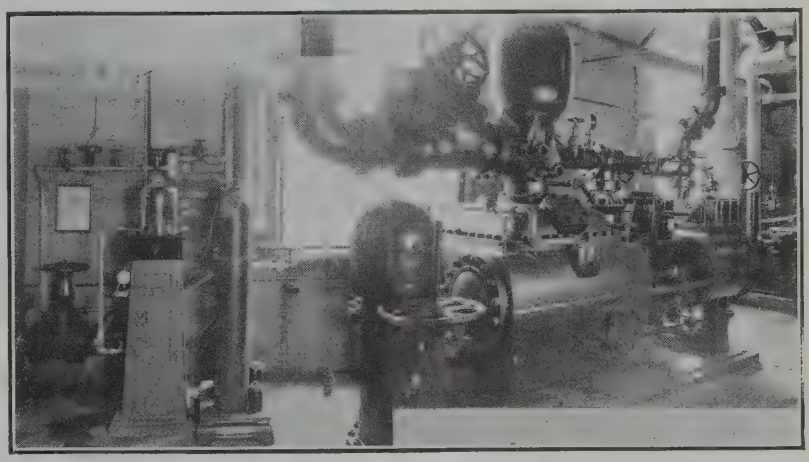
Provided, that, where such physical connections now include two gate valves with indicator posts, two check valves of the Special Factory Mutual Fire Insurance design or equivalent with drip cocks and gauges for testing, all located in a vault of water-tight construction accessible for ready inspection, the date of discontinuance may be extended until July 1, 1928.

Regulation 15-b. Permissible arrangements where dual supplies are used. If a potable water supply is used as an auxiliary supply delivered to an elevated tank or to a suction tank, which tank is also supplied with water from a source with which cross-connections are not permitted by Regulation 15-a, such tank shall be open to atmospheric pressure and the potable water supply shall be discharged at an elevation above the high water line of the tank."

Subsequent to the enactment of these regulations, protests of representatives of certain industries in the state were made to the Public Health Council. Following these protests, the council conferred with manufacturers, health officials, water supply officials, sanitary engineers, fire protection engineers and insurance organizations and held numerous hearings in various parts of the state, as a result of which the council became convinced that the severance of connections between potable and polluted water was demanded for the protection of the public health.

In view of the various hearings held and the time consumed, a great many industries had delayed taking active steps to make the necessary construction changes to conform with the regulations of the code. Accordingly, requests were received from a considerable number of industries, requesting extensions of time, due to delays, many of which were unavoidable, in having the necessary changes made to comply with the code.

Special Fire Pump Chlorination.—Moreover, in May and June of 1926, a new development in chlorination apparatus was brought to our attention which, it was thought, possibly might permit certain plants to chlorinate their auxiliary supplies and render them potable from a public health standpoint. Tests of this so-called special fire pump chlorinator equipment were made covering a period of some six weeks, as a result of which it was determined that the apparatus with proper supervision would be capable of effectively chlorinating an auxiliary supply under intermittent operation of fire pumps and thus rendering such auxiliary supply potable, provided it was only moderately polluted.



A Fire Pump Chlorination Installation

Requirements for Installation.—Such installations must, however, meet the following requirements:

1. The water supply must not be so grossly polluted that it cannot be effectively chlorinated.
2. The fire pump must either take suction from an open well or sump or there must be a municipal water supply available having a pressure at least three times as great as the pressure on the suction of the pump.
3. The chlorination equipment must be of a type approved by this department and so equipped as to continuously waste a small amount of chlorine solution and provided with solenoid or steam operated valves so regulated that immediately upon the starting of the pump it will apply chlorine at a rate of not less than 20 lb. of chlorine per million gallons of water pumped.
4. Platform scales must be provided

for checking the loss of weight of chlorine.

5. Plans of the installation, together with report and sufficient data to pass upon it, must be submitted for approval to both the local water authorities and to the State Department of Health.

6. Reports of the results of daily orthotolidine tests of the chlorine solution wasted and the amount of chlorine wasted or used per day must be submitted at least monthly to the municipal water supply authorities.

7. Chlorinators on all auxiliary industrial or fire supplies must be inspected regularly and at frequent intervals by local water supply authorities.

8. The cross-connection between a potable municipal supply and a chlorinated auxiliary industrial or fire supply must be equipped with double check valves of the "all-bronze" type placed in an accessible chamber and properly equipped for testing and inspection. Such check valves must be inspected and tested at least monthly and taken apart, thoroughly cleaned and any worn parts replaced at least yearly.

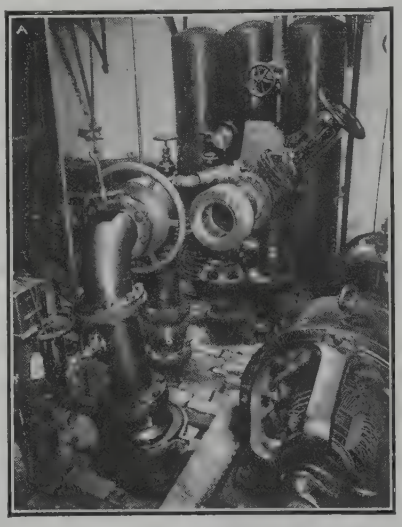
9. Discharge valves on the fire pumps must be closed whenever the pumps are turned over for testing.

10. Any approval by the municipal and water supply authorities or this department will be given only on condition that the chlorination apparatus is satisfactorily installed, operated and maintained at all times.

Results of Plant Changes.—To date there have been some 60 fire pump chlorinator installations authorized among 55 of the industrial plants of the state. A recent report of one of the insurance associations on the results of plant changes made to comply with the provisions of the code, show that out of a total of some 147 plants listed, the total estimated cost of changes necessary to comply with the Sanitary Code was about $350,000. These changes included installation of all-bronze check valves in pits, erection of gravity and suction tanks and changes in yard piping. It was estimated that the cost of heating gravity and suction tanks would be from $250 to $400 annually. It is further estimated that the fire pump chlorinators would use up approximately $110 worth of water and chlorine per year, besides the necessary supervision, making a total annual maintenance charge for the chlorinator of say $200.

There have been in some special cases, considerable expenditures necessary to eliminate satisfactorily cross-connections and at the same time provide industries with adequate fire protection. In one of these instances, the industry spent over $25,000 in placing new mains to carry the polluted water supply and thus eliminate the cross-connection with the public water supply.

Cross-Connections Eliminated Wherever Possible.—It must be borne in mind, however, that in our program of safeguarding cross-connections, it has been our endeavor to eliminate the cross-connections wherever possible. Moreover, the quality of the water supply to be treated is carefully considered and in six instances, applications for permits for the installation of a fire pump chlorinator were denied, because it was found the sources of the fire pump supplies were too polluted to permit of chlorination being relied upon. Furthermore, in all instances where fire pump chlorinators have been installed, it has been required that double check valves of the all-bronze type be installed in place of the old iron body type.



Front View Showing Swing Joint Arrangement Eliminating Cross-Connection Between City or Potable Water Supply and Emergency Non-Potable Fire Supply

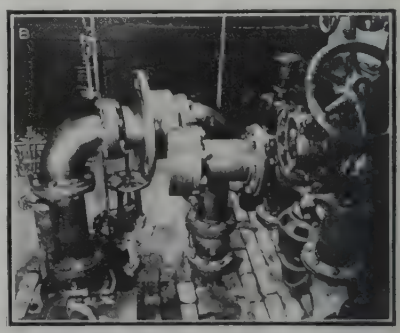
Throughout the past two or three years, many conferences and investigations have been made with public water supply authorities and representatives of industries, with particular reference to the elimination of cross-connections. In the majority of these instances some satisfactory and reasonable plan or program could usually be found for eliminating the cross-connection. In all instances, in which permits have been granted for the installation of fire pump chlorinators, the need for careful and constant supervision of the apparatus has been emphasized. In fact, it has been pointed out that should the fire pump chlorinator be neglected, the permit would be revoked and it would be required that the industry eliminate the cross-connection.

Chlorinators Operated Satisfactorily.—The earlier fire pump chlorinator installations have been in service at the time of this writing for some six months. The majority of them have been in operation at least four months. Monthly reports on the daily results of tests and observations of the operation of the chlorinators received by the department indicate that the fire pump chlorinators have, with minor exceptions, operated satisfactorily. Inasmuch as this has been an entirely new departure, it was to be expected that there might develop some features which might not be entirely satisfactory. There have been but few instances, however, where such conditions have occurred and where they have, it has been possible to determine the cause and correct the same. Although six months would be somewhat too short a time to predict with certainty the future of the fire pump chlorinator, it would appear that, given proper and careful daily supervision and maintenance, the equipment is capable of satisfactorily chlorinating an auxiliary supply under intermittent operation and render such auxiliary supply potable, provided it is only moderately polluted.

The Swing Joint Arrangement.—There has also been developed a so-called swing joint arrangement which, so far as is known, has not hitherto been employed, at least on a commercial plant size scale, to make available either one of two water supplies. By this type of arrangement, the city supply, which is normally used, can be shut off and the industrial distribution pipe line changed by means of a swivel joint to connect with the fire pump supply which, thereafter, can be placed in use. Although such a system has been approved by the State Health Department in a few instances under certain conditions, the insurance authorities have not looked entirely with favor on this type of connection, except under very favorable situations, inasmuch as it is open to the following possible objections:

1. There is a period of time during the making of the change when no water supply pressure is available.

2. Instead of having two sources of supply available simultaneously for fire fighting purposes, as is the case where both the city and the fire pump



Side View of Swing Joint Arrangement Eliminating Cross-Connection Between City or Potable Water Supply and Emergency Non-Potable Fire Supply

supplies are connected through suitably arranged check valves, there can be only one source of supply used at a time. So far as we know there have been only about a half dozen of such installations throughout the state.

Cross-Connections on Water Service Lines.—In addition to these cross-connections on fire supply lines and mill service supply lines, cross-connections have been found on water service lines for priming pumps, for boiler feed, for cooling purposes, etc., usually made for use in emergency to obviate shutting down some particular piece of machinery and frequently made for convenience or through ignorance. When such cross-connections have been discovered and the matter has been taken up both with the authorities in charge of the water supply and the owner of the property or the industry, prompt steps have been taken in all instances to eliminate these cross-connections which may oftentimes be more dangerous than the well regulated and supervised larger type of cross-connections.

Although the Sanitary Code places the responsibility for eliminating cross-connections on the local water supply authorities, the department has been called upon for advice and assistance by the local water supply authorities as the problem of eliminating the cross-connections, particularly in the case of the larger industries, involves special engineering questions. The importance of making careful inspections of piping systems at industrial plants to discover any possible cross-connections has been forcibly brought to our attention and we have emphasized to the local authorities the need for such inspections. It would appear that the painting of pipe lines in colors or with colored bands will undoubtedly greatly reduce the hazard from cross-connections made through ignorance or carelessness. Such standards are already in use in power house practice.

Careful Study of Individual Conditions Necessary.—Although conditions are found to be somewhat similar in numerous instances, there are hardly any two plants having the same hydraulic conditions and it has been found necessary to make a careful study of the conditions at each individual plant in order to determine the most satisfactory and economical method of eliminating the cross-connection. Moreover, in all cases the industries and manufacturing establishments have been advised to take the matter up with their fire insurance authorities, in order that any improvements or changes in the piping system will be made with the approval of the fire authorities.

I would be remiss, indeed, in this brief summary of the action taken to eliminate cross-connections in New York State, if acknowledgment were not made of the splendid cooperation and assistance rendered by the representatives of industries and insurance authorities. Indeed, without their cooperation, the progress already made in this very important and large undertaking could hardly have been accomplished within so short a time.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 46th Annual Convention of the American Water Works Association.

Chlorination of Pipe Lines Under Construction

By JOHN R. McCLINTOCK
Construction Foreman, Indianapolis Water Co., Indianapolis, Ind.

The company for which I work has for some time required its construction foreman to see that the pipe is not only well "swabbed" and made thoroughly free of any loose matter before placing it in the trench, but also that it is well chlorinated after being placed therein.

The process by which this is done is very simple and does not require a great amount of time. It is as follows:

Make the "first end" connection and as first length of new pipe is laid or connected to existing main, one can or container of hypochlorite of lime should be shaken into that length of pipe and at each interval of eight lengths of pipe another container should be emptied into that length of pipe and so on to the completion of line.

However, when a hydrant or a valve also is set in the main the valve may be closed and the line filled slowly from point of first connection until first appearance of water at hydrant, when the hydrant should be closed and the water allowed to stand for 30 minutes and then flushed thoroughly until no odor of chlorine can be detected in the waste water.

This facilitates the work of backfilling and flushing trenches by getting part of the new line into service. Water used to flush out pipes need not be wasted, for where economy in amount of water used is an item, it can be profitably used to flush or settle back-filled ditches.

On first thought it appears proper to make an allowance for the relative capacity of different sized mains, but we believe it more likely to be handled successfully if construction foremen are instructed to place a given quantity at the head of each 100 ft. of pipe laid and flush it out thoroughly when job is complete up to an end hydrant.

The reason for this is that for 36-in. pipe at a dose of 100 lb. per million gallons, the quantity required is 1 lb. per 100 ft. In either case it is necessary to flush the line until no odor of chlorine is detected at discharge hydrants. The removal of chlorine from the line to this degree will insure thorough cleaning by displacement alone in addition to the sterilizing effect.

While the pipe line is incomplete all openings should at all times be kept plugged, which will prevent circulation of air and thus preserve the strength of chlorine until its final removal from the pipe. After completion of the pipe line care should be taken to see that, in the removal of this treatment, none should be allowed to enter any existing line.

To get the best results it has been our method to open a fire hydrant at the furthest end of line, then to open a valve at point of beginning, letting water flow through the pipe slowly until it appears at the hydrant, shut it off for period of about thirty minutes, then open up and blow out thoroughly until the water shows clear.

At this point, reverse the operation by closing the valve and hydrant first opened and then open the valve and hydrants at opposite end of line and blow out until water is clear and free of odor of chlorine, after which open all hydrants on the line, then proceed to turn on all intersecting lines beginning at end of line from which water is flowing, still keeping hydrants open to carry out any chlorine that may have lodged in ends of branch lines and lastly open up the valve on furthest end of line.

In case there is no hydant on the end of the pipe line thus treated, it is necessary to shut off the adjoining section, opening up several hydrants first. Then open valve from new section, letting water blow out as speedily as possible that the line may be cleared of all effects of treatment before being taken into service lines of consumers.

This instruction to disinfect newly laid pipe lines should in no way, however, lead construction foremen to reduce the degree of care they have previously used in cleaning and flushing such lines.

As a matter of general information the chlorine container stocked by commercial dealers holds 12 ounces. A case of these contains fifty and costs $5.60.

In conclusion, let me emphasize the point that water used in flushing out treatment need not be all waste as it can be used to flush or settle backfilled ditches.

In case of a "dead end" where it is impossible to blow out the line, the only thing to do is to use extreme care that the pipe used therein be well "swabbed out" before being laid.

Acknowledgment.—The foregoing is an abstract of a paper presented before the Indiana Section of the American Water Works Association.

Airport Design and Construction

Fundamentals and General Details

By PHILIP R. LOVE
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PROBABLY no other phase of aeronautical development offers as fertile a field for the exercise of enthusiastic ignorance as does the selection and preparation of airports.

Aviation is neither a sporting proposition nor a theatrical enterprise, but a definitely and well-established transportation utility or agency, the widespread acceptance and adoption of which is as necessary today for a town or area anxious for continued growth as was similar acceptance and adoption of the railroads three-quarters of a century ago. Even the most casual observation compels recognition of the fact that the biggest and best cities are those with the best transportation facilities, which connect with the rest of the country and the world. Aviation is just one more transportation agency, and the city of tomorrow will grow with it or stagnate without it.

Most cities appear to realize this more or less clearly and are attempting to establish terminals or ports for the handling of this new form of transportation; but the whole development is so new, and so few persons have a comprehensive grasp of the elements and the need of ports, that much loud and vigorous effort is being misapplied.

Probably as common an error as any is the tendency to under-estimate the cost of adequate facilities. A good port is an investment in future growth and prosperity, and, in common with other things mundane, can be expected to pay return on the amount of the investment, and no more.

This error is most generally reflected in the unwise procurement of a port site on the basis of the price of the land. If a railroad desires a station site, a chain-store group a site for one of its stores, a theatre circuit site for a new playhouse, or any other business—except aviation—a site for the conduct of its activities, it considers the whole question from the viewpoint of attracting patronage rather than from the viewpoint of minimum cost for a certain-sized tract of land.

As long as flying is new in a community and offers allurement as a spectacle, people will flock to a port as to any other big free show; but as soon as it settles down—and it doesn't take long—to the routine arrival and departure of passenger, mail, and express planes flying on schedule, it must offer convenience to its potential clientele—or there will be none. The man or woman who goes into raptures over the fascination or the beauty of aerial transportation is frankly open to the suspicion of exaggerating matters, for hour after hour of flying over country which one has seen time and again is as monotonous as any other type of travel. As against this it is speedier, cleaner, and fully as comfortable as any other method, but this is soon outweighed if one has to travel long distances over indifferent roads to and from the ports at each end of the air journey.

Site Should Be Easily Accessible.—Thus it is that due consideration should be given to quick and comfortable access to town if full value is to be received from the port investment, and the search for a site should begin as close to the downtown district as possible. Nor should the fact that property happens to be occupied and used for other purposes cause it to be rejected for that reason alone, for the cost of its acquisition with the resultant scrapping of some present investment may be wholly justified by its comparative convenience of location.

Of course, it goes without saying that the fundamental requirement in the selection of any port is that of safety, for all other advantages combined cannot outweigh the disadvantage of immediate or adjacent hazards. As to what these hazards are, if one does not know and is charged with the selection of a port he had better not try to pick a site, for too many a poor devil has come crashing down in a flaming heap of shattered spars and shredded fabric on or near ports cluttered up with bordering trees, high stacks, railroad yards, high-tension lines, crowded buildings, and the like. Enough to fill many books could be written on this one phase of selection, and one could read them all and still not know the half of it. The answer is that if one has not flown in and out of ports with good ships and cranky ships, with good motors and those not so good, in good sunny weather, and in thick and blustery twilight, he should find some one who has, and then get his help.

Important Points to Be Considered in Selecting an Airport Site.—However, with a field properly selected as to availability to town and freedom from immediate and adjacent hazards, one is still a long way from a sane decision until many other points or features have been weighed. Some of the principal ones to be considered are:

Avoid an area habitually clouded by smoke or frequent local fogs. Specifically, if a town is an industrial center with soft coal as the principal fuel, or one where residence heating is done with the same material, it will be found that the side toward which the prevailing winds blow will have the poorest visibility and should be avoided. Again, a river, lake, or bay on one side of the town may occasion frequent low-lying morning fogs that will completely blanket a field or port located there, and should therefore be avoided.

Drainage.—Another thing to consider is drainage. If the area overflows with spring-flood backwater, keep away from it. Up to within the last two or three years great stress was laid on the selection of sites as "level as a floor." Today such sites are taken only as a last resort, for they require a large sum for adequate drainage—if they can be drained at all. Basically, any field should have sufficient slope at all points to preclude the pounding of water. The ideal field in this respect is one rising gently from the mid-point in the direction of the prevailing winds. This is advantageous from an operating and lighting standpoint as well as for drainage, for it offers descending grades from the rim for the acceleration of ships taking off; ascending grades for a ship landing in midfield; and better illumination of the far side of the field from floodlights placed along one side. Contrary to this a field with a ridge in the middle should be avoided in that the grades are wrong for either landing or taking off, the light from a unit along one side is cut off at midfield, and too pronounced a ridge introduces the possible hazard of collision of two planes on the ground and traveling in opposite directions.

Next, the soil should be observed or studied. A sandy loam with a good top soil is best, for it permits a good stand of turf and allows the absorption of rain, which serves to keep the field from getting muddy and holds the moisture necessary for good turf.

With all of these things watched, there will probably still be need for more or less subsoil drainage. Depending on the character of the soil and the turf, a goodly portion of the water falling in a hard rain can be allowed to flow off over the surface, but nearly every field will have some areas requiring porous drain lines of some sort. Clay or concrete pipe laid with open joints, preferably in rock-filled trenches, is quite commonly used for this purpose, but should be of good quality and laid deep enough in the ground to withstand crushing under the impact of landing planes. In addition to this the manu-

facturers of corruglated-iron pipe have developed a perforated pipe for this service. One thing which should be avoided is cast-iron or steel manhole covers or inlet gratings flush with a turf field, for the softening of the adjacent area will make sudden contact with these structures dangerous.

Another factor in connection with drainage is frost, particularly when it is coming out of the ground in the spring. This is apt to create a condition where the subsoil and subdrains remain frozen after the topsoil has become a mire. This further dictates the selection of a sloping area.

Grading and Shaping Field.—With the field selected and disposal made of the drainage problem, the next step is grading and shaping. Usually there will be some portions requiring more or less grading. In general all ridges or hollows should be lowered or filled until the gradient at no point exceeds 2 per cent. In addition to this some additional grading may be required to eliminate shadows when the field is lighted from the margin. The rows in cultivated fields generally present a formidable appearance, but are not very difficult or expensive to eliminate if attacked with the proper equipment. Disk harrows and a heavy steel drag usually work the best on these—both tractor-drawn. The best disks are the "double" type with two gangs in tandem, one deflected in and one out from the center. The first time over these should be drawn parallel with the rows, and then at right angles. The best drag which has been developed for the next step is one made of structural-steel channels laid at right angles to the direction of the travel and overlapping one another like shiplap, the slope being upward to the front with the legs of the channels standing up and the front web of each channel bearing on the rear leg of the preceding member. These are fastened to side runners—also channels—with angle clips and bolts. The whole is dragged behind the biggest caterpillar tractor available, preferably the largest made, which will handle a drag about 16 ft. across and 12 ft. long, and which will put the field in excellent condition where only a small amount of work with a road machine will be required for completion.

If there is already a stand of tough but rough or irregular turf on the field or portions of it, it may be necessary to turn this over with a plow before harrowing and dragging; while if a field of corn is attacked late in the season after the roots are fully developed, the corn should be pulled instead of cut to avoid the trouble occasioned by these roots and stubbles rolling up on the surface.

If the field was originally covered with Bermuda or other equally tenacious grasses they will generally come up through and resod the area. If not, either sodding or seeding will be required. Sodding the whole area is usually out of the question, but "spot" sodding with plants on about 3-ft. intervals with Bermuda or other running grasses will give a fair stand at the end of a full season, particularly if seed is added. If the field is finished in the fall, winter wheat, oats, or rye makes a good winter crop and mother crop for grass seed planted in the spring, particularly if 200 lb. or so of sulphate of ammonia or other good fertilizer is broadcast with the seed in the spring.

Location of Buildings.—The location of buildings on the port calls for the observation of a few "don'ts." Don't locate them where they must be crossed by planes, either landing or taking off, on the best approaches. Don't locate them where the prevailing winds will keep them full of dust from the field. Don't locate them in a low place where heavy rains will wash through them across the field, or so low that floor drains or plumbing fixtures cannot be given good outlets.

In general, locate them where good access to good roads leading from the port is economically available; locate them on some established and orderly plan with their faces or ends lying along a definite line instead of setting at various angles. If possible, leave sufficient room between the buildings and the edge of the port to permit of a proper landscape treatment, for the mere fact that an area is devoted to airport purposes does not mean that it must be ugly to be useful. Give thought in the grouping of the buildings to future use and to comfort—for instance, do not put a service or shop building where motors will roar on test night and day right adjacent to the administration building, pilots' quarters, or other places where reasonable cleanliness and quiet are desired. In other words, make the grouping along studied lines instead of allowing any and every one to put what they please where they please.

As to the detail and the character of the buildings themselves, "Costly thy habit as thy purse can buy, for the habit oft proclaims the man." A heterogeneous bunch of overgrown corrugated-iron shanties sprawling at will along the edge of the port will promptly discourage any substantial and attractive future development, and lower the value of all adjacent property as well.

In their eagerness to "get on the air map" many cities have done this very thing, excusing it with the vague apology that these are but temporary facilities, and that other and better ones will be provided "when the industry gets on a more stable basis." However, the first few buildings erected at a port generally established the character of the permanent development.

As to building materials, let these be as fire-resistant as possible, and design the buildings to permit the installation of sprinkler systems at some later date if not when they are erected. Long spans and clear areas are necessary, so the best general type of construction is steel columns and trusses and light-weight roof structures such as 2-in. tongue-and-groove wood sheathing on 7-ft. or 8-ft. spans, surmounted with a good grade of built-up roofing. Many manufacturers are urging the use of crimped steel sheets covered with fiber insulation, in lieu of the wood sheathing, but the cost is higher and there is honest question as to whether or not the thin sheets such as they urge will withstand fire and corrosion any better than wood.

Important Features of Airport-Building Design.—The structural elements of the buildings must be carefully studied and the members must be appreciably heavier than those in similar buildings located "in town" where adjacent buildings shut off much of the force of the winds, for the very nature and location of airport buildings subject them to winds with a full sweep of half a mile or more.

Another fundamental of airport-building design is to provide plenty of natural light. This means as much window area as can be obtained without sacrifice of stability or architectural appearance. Steel sash and lots of it is the best answer to this demand, and particular attention should be paid to proper design of mullions and other structural features so that they will withstand wind velocities and pressures. Also wire glass should be used for this same reason, for a properly and economically designed building will deflect and react more or less under wind action, and thin, non-reinforced glass has a tendency to break under such conditions.

Doors deserve much consideration. With the increase in wing spreads, doorways are becoming both wider and higher. Here again the wind is a real factor. On some hangars which we have built recently the doors are 120 ft. wide and 22 ft. high. To withstand the wind these doors must have the structural ability to carry a heavy horizontal load. This means heavy stiles and rails and substantial panels, with a correspondingly heavy weight per lineal foot of door. The most generally accepted practice is to make these doors of steel, and to slide them along floor tracks on well-designed wheels or rollers. Several manufacturers have designed such wheel or roller units that permit the doors to operate around corners, and this general practice is recommended.

The color of buildings should be a light shade of buff or tan—or even white—to insure the highest possible visibility both day and night.

At first, airport buildings were hard to treat architecturally, but a definite type of characteristic "airport" design is coming to the fore rapidly, and we are learning that sympathetic treatment of mass and color will give buildings a really pleasing appearance

without exorbitant cost, and the whole industry has ascended to a plane where this is not only justified but demanded. Care should be taken, however, not to lean over backward in this respect in the desire to outdo the rest of the country, for after all the flying industry is like any other industry in that it must show a profit or else fall of its own weight.

The buildings required at a port vary with its location and use, but certain specifications governing restaurant facilities, sleeping quarters, toilet facilities, waiting rooms, etc., must be observed if the port is to receive a favorable rating from the Department of Commerce. Copies of these specifications, or requirements, may be obtained from the department for the asking, so space will not be taken here to repeat them. These specifications also set forth the sizes and shapes needed on the fields themselves for the obtainment of the various ratings, and should be consulted before any other steps tending toward port selection and development are taken.

Lighting for Night Flying.—With field and buildings both prepared, there is still another requirement before a field can be given its best rating. This is lighting for night flying, which latter is increasing very rapidly, and for which provision must be made at all good ports. The basic requirements for lighting are for boundary lights at intervals not exceeding 300 ft. completely around the field; a beacon light of certain characteristics to guide the flier to the field; a ceiling projector to determine the height above ground of the bottom of the cloud ceiling in heavy weather; red lights atop all adjacent buildings, pole lines, tall trees, or other obstacles around the port; approach lights to indicate runways or the best landing strips; an illuminated wind cone or other indicator showing wind direction; and a floodlight, or floodlights, to illuminate the landing area to a certain density. In addition to this, part or all of the buildings around the port should have their sides illuminated in their entirety and their roofs wholly illuminated or with illuminated signs thereon. Definite requirements for all of this lighting are set forth in the specifications already mentioned, and these must be followed if a creditable port is to be provided.

Immediate and Adjacent Hazards.—The problem of immediate and adjacent hazards varies with the use or uses of a port. Transport planes with heavy passenger loads both come in and go out on long, flat glides, so that the approaches to a transport field should be free from any high obstructions for an appreciable distance to obviate the necessity of either coming in high or having to pull a plane into a steep climb in taking off. An air-mail or taxi field used solely or primarily for light, fast planes, and skilled pilots does not require so much attention given to approaches, for planes in this service can come in and go out at comparatively steep angles. The third type of flying is school work, and more attention must be given to the approaches of a school field than to either of the other two, for undershooting, overshooting, or stalling on too steep a climb on take-off sometimes occasions unexpected forced landings beyond the limits of a field. Unquestionably, with the increase of all types of flying we shall soon face the need of segregating the three types, particularly on account of the hazards of school flying where the green pilot has a whole day's work mapped out for him in the handling of his own craft and cannot be trusted not to cut across the bows of a heavily loaded transport plane floating in to land. If the selection of a port is for one of these specific types of flying, the approaches and general location may be gaged accordingly; but if the field is for all types of flying activities during its first months or years, it should be laid out to the most exacting requirements.

Probable Cost of an Airport.—A port wherein intelligent attention and treatment have been given to these foregoing items will cost probably at least a quarter of a million dollars for an A-1 rating, or one on an unobstructed and unpenalized area 2,500 ft. square with adequate buildings and lighting. This price tag, however, cannot be applied without study of the particular problem involved, for real-estate costs, grading, drainage, and all of the other items will vary manyfold in different locations. For instance, one field on the route of one of the transcontinental transport lines is located within a few minutes' ride of the heart of one of the largest cities of the mid-west and the property alone has a valuation of much over a million dollars, while another of the ports on which this same company is to operate, but which is located alongside a railroad right of way out in the level plains further west, is larger and better in every way, except that it is not located near a big city, but will cost but an eighth of a million in its entirety.

Unquestionably, any such amount as either of these is beyond the limit of what small cities or towns can spend. This, however, should not act as a permanent deterrent to these smaller places, for air transportation has much to offer them in its ability to connect them with the outside world, and a much smaller amount of money will provide fields or ports with limited accommodations adequate for a smaller amount of flying. With a limited amount to spend, these communities should not jump too hastily into any program, but should confer with the Department of Commerce for advice and guidance as to how to proceed.

Runways.—All of the previous discussion has been based on the development of fields of the "all over" type, or ones with their full areas turfed in a manner to permit landing or taking off at any point. In many ways these are the ideal fields and, with fair soil and drainage conditions, they will stand up fairly well under a reasonable amount of flying. With the advent of the large transport ships, however, turf fields are proving inadequate. Visualize a 5-ton truck speeding across a rain-soaked meadow at 70 miles an hour and the reason for this inadequacy is apparent. For such service hard-surface runways are needed, but these should be placed so as to interfere as little as possible with the "all over" use of the field by smaller planes. Location of these runways must be studied very carefully with due regard to prevailing winds, safety of approaches, and many other things.

Opinion as to the best materials for runways is varied. Each must be judged on its merits as to its adaptability to the prevailing soil and climatic conditions, and its economic availability. Generally speaking, it may be said that materials and applications suitable for highways under comparable conditions of soil, climate, loadings, and density or frequency of traffic are applicable to runways.

Heating.—Another feature of airport-building design that has been slighted to date is that of heating. Our organization observed and studied hangars and shops at most of the ports in the East and Middle West during this past winter. With due deference to all of them, not a single one was found that was adequately, evenly, or economically heated. Basically, a hangar is high, wide, and not particularly handsome; has terrific heat losses due to its large glass areas; and lets all out of doors come inside whenever the doors are opened to admit or emit a ship. The most marked tendency is for heat to float up toward the roof and leave the floor unbearably cold. After studying the problem from every angle the opinion was formed that the best heating would come from the installation of extremely high-velocity, large-volume, and reasonably low-temperature units in such a manner that cold air would be taken from the floor, heated to a reasonable degree, and emitted just below the bottom chords of the trusses and at angles and velocities to jet it clear across the building to impinge on the far wall where, in cooling, it would descend and travel back along the floor to the unit for recirculation. Basically, at least six air changes per hour were deemed imperative. Several of these installations are being made this spring and summer, and this time next year we shall know how well we have answered the question.

Acknowledgment.—The foregoing is a paper presented May 28th at the third national meeting of the Aeronautic Division of the American Society of Mechanical Engineers.

Data on Steam and Electric Pumping Stations

Comparison Between Pumping Plants of Four Cities

By J. F. LABOON
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COMPARISONS of costs as between steam and electrically driven stations, including gas and oil where available at reasonable prices, are usually made in determining the most economical kind of power. A case in point is that of Wheeling, W. Va., where electric power supplanted steam, although coal was mined practically at the front door of the boiler house. The actual cost of this electric station was $310,000. The estimated cost of the steam station was $604,000. The fixed charges and operating expenses for 15 M.G.D. production at the electric station was $113,875, or a pumping cost of $20.80 per million gallons; for the steam station the total estimated cost was $133,000, or $24.30 per million gallons pumped.

Power is furnished the city water works under a special municipal tariff based on a guaranteed load factor specified at the beginning of the year, which gives an average power cost of 8.59 mills per kw.-hr. Slip ring motors were used in conjunction with a synchronous condenser to maintain unity power factor.

Costs at Nashville, Tenn.—Nashville, Tenn., has been rehabilitating its water works intensely for the past seven years, placing into operation in September, 1927, a new boiler house, boilers and auxiliaries. Electrically-driven pumps have been installed since 1926 to augment the pumping capacity. Figure 1 shows the results obtained under various conditions of steam pumpage, that is, with the old station operating a vertical triple expansion pump with one lift from the river to the storage reservoir; the improved pumping station with two horizontal uniflow engines operating vertical centrifugal pumps for low service, and a turbine-driven centrifugal pump on high service; and later with the new boiler plant in operation. The motor-driven centrifugal pumps are too recently installed to permit of any direct comparative data.

It will be noted that the station duty dropped off with two-stage pumpage with the uniflow and turbine-driven centrifugals in operation, but that this duty was materially improved upon installation of the modern boiler plant. Actual costs of operation have been omitted inasmuch as direct comparison of such costs with those of a similar plant might be productive of confusion, rather than good, since labor conditions and rates together with fixed charges vary with local conditions. Therefore, station duties have been given as a measure of economy, instead.

Pumpage at Erie, Pa.—Some direct comparison, however, can be made between the Nashville, Tenn., and the Erie, Pa., plants inasmuch as both involve in many respects the same types of pumps and conditions. Figure 2 shows station duties and conditions of pumpage at Erie. In this case, too, it will be seen that economies were depressed as soon as the turbine-driven centrifugal was put to protracted use, such as was the case in 1926 and 1927.

In computing station duties, the motor-driven units are not included. Their function in the figure is to show the proportionate use that is made of the various pumps, or types of power.

The Erie plant offers some direct comparison between costs of steam and electric-driven units inasmuch as a 12 million gallon motor-driven high service unit was installed in 1925 to augment the vertical triple expansion and the rest of the direct-acting steam units. Table I shows comparative costs of steam and electric power pumping at the main station.

In allocating charges for depreciation, the electric unit has been charged with the proportionate space it occupies in the station and labor required for operation. Power is purchased on a regular tariff basis. Electrical pump-

NASHVILLE, TENN.—STEAM STATION

PERCENTAGE OF TIME RUN

PUMPS	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
WORTH. #1 H.S	2.4	0.6	DISMANTLED								
WORTH #2 H.S	0.4	0.5	0.3	DISMANTLED							
HOLLY H.S	1.9	0.3	0.2	0.3	0.04				DISMANTLED		
ALLIS H.S	95	99	97	79.5	32	49	20.6	12.7	19.4		
H.S TURBINE & L.S UNIFLOWS				17.3	66	93	78	86.6	80.6		
ELECTRIC- L.S & H.S.								12.5	12.2		
PUMPAGE MGD	13.6	14	14.9	15.1	15.6	16.	16.1	17.6	18.8		
COAL-TONS	9424	9149	10280	10967	11698	15954	14950	14635	14153		
STA DUTY MILLION FT LBS/100 COAL	71	78	73.5	73	70.5	54.5	58	62	70.3		
COST COAL PER TON	4.70	4.20	4.05	3.62	3.36	3	2.73	2.21	2.75		
GALS./FT. HEAD /# COAL	85,800	94,000	88,200	87,700	84,800	63,500	69,700	74,600	84,900		

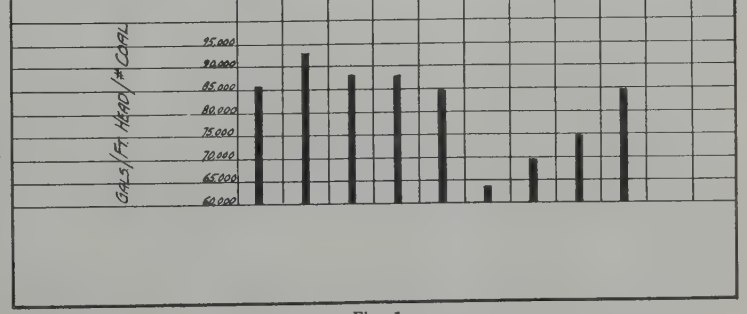

Fig. 1

Table I—Cost of Operating High Duty Pumps, Foot of Chestnut Street, for Year Ending Dec. 31, 1927

	Steam Power	Electric Power	Total	Cost Per M.G.
Superintendent, chief operator and clerk	$ 3,910.43	$ 454.25	$ 4,364.68	$ 0.496
Operating labor	7,640.64	883.42	8,524.06	.970
Steam for engines 5, 6, 7	59,263.09	.....	59,263.09	6.740
Steam for miscellaneous equipment	3,885.18	204.49	4,089.67	.465
Electric power purchased engine No. 8	.....	29,239.06	29,239.06	3.326
Lubricants and waste	415.14	.70	415.84	.047
Electric light and power produced	1,280.11	67.39	1,347.50	.153
Other supplies and expenses	523.05	27.52	550.57	.063
Repairs and maintenance:				
Buildings	3,784.71	199.18	3,983.89	.453
Engines and attachments	10,234.37	311.02	10,545.39	1.200
Miscellaneous equipment	442.44	23.30	465.74	.053
Depreciation	12,776.57	2,842.68	15,619.25	1.777
Total cost	$104,155.74	$34,253.01	$138 408.74	$15.743
Head in feet		257.5	359	
Pumpage in gallons	6,837,339,600	1,955,030,000	8,792,369,600	
Foot pounds per dollar	140,902,300	170,799,260	.....	
Average rate per K.W-Hour	..... .99228 ct.			

Table II—Cost of Operating Electric Pumps—Booster Station, 26th and Sigsbee, for Year 1928

	Amount	Cost per M.G. Boosted
Superintendent and Clerk	$ 832.00	
Operating Labor	3,793.06	
Electric Power	11 366.42	
Oil and Waste	4.25	
Maintenance and Repairs:		
Pumps and Motors	402.86	
Miscellaneous Equipment	166.93	
Buildings	340.51	
Heating and Lighting	255.77	
Miscellaneous Supplies and Expense	162.49	
Depreciation	1,759.44	
Cost of Boosting 1,901,445,500 Gallons or 5.2 M.G.D. from Low Service Mains at 26th and Sigsbee to High Service Reservoir, a head of 96.2 ft.	$19,083.73	$10.036
Foot Pounds, per Dollar of Cost	79,700,000	

Average Rate of Power per K.W.H.—1.337 ct.

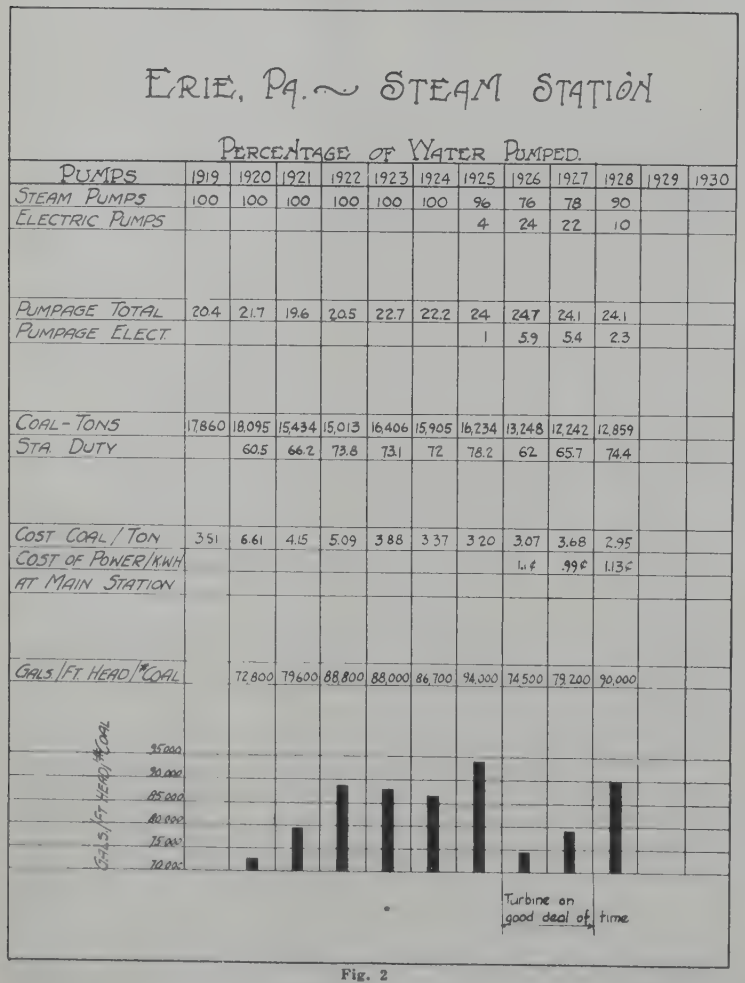

Fig. 2

ing in this case is justified by virtue of its economy. The difference in heads is due to the use of the electrical unit on Booster service head, but this difference has been wiped out by the installation of a new Booster station. The impeller of the 12 M.G.D. electrical unit has been cut back to permit of greater efficiencies at the reduced head under which the pump operates now. The pump was out of service for six months in 1928, pending the change in the impeller. Therefore, the pumpage by this unit was only 10 per cent of the total during that year as shown in Table I.

Cost of Operating Electric Pumps.—A new booster station consisting of two 5 M.G.D. and one 8 M.G.D. motor driven units has been completed to relieve the head conditions at the old station. This station has been in operation since December, 1927.

Costs and economies are given in Table II for the Booster station, electrically operated, for the year 1928.

Power for this station is costlier than that for the electrical pump at the main station, and this coupled with low head pumpage, combine to reduce economies somewhat below those found for the 12 M.G.D. unit at the main station. It is of interest to note that the new 16 M.G.D. pumping station and filtration plant now being designed for Erie, as an additional supply, will be electrically operated.

Steam Pumpage at Fostoria, O.—In contrast to the trend towards electrical pumping units as exemplified in the preceding paragraphs, is the case of the pumping station at Fostoria, O., where a study developed that it was more economical to install a cross-compound steam pump than an electrically driven centrifugal pump for high service. Table III gives the details of the comparison of costs as be-

Table III

Actual Cost of Steam Equipment

3 M.G.D. Cross Compound Pump	$23,500
Pumping Foundations and Building	8,200
Two (2) 3 M.G.D. Engine Driven L. S. Pumps	4,100
Foundations	500
Water and Steam Piping	9,300
	$45,600
Engineering and Contingencies	4,400
Total	$50,000

Estimated Cost of Electrical Equipment

6 H. S. & L. S. Pumps Installed	$ 9,000
Foundations	1,000
Piping	7,000
Improvements to Pump Room	2,000
	$19,000
Engineering and Contingencies	2,000
Total	$21,000

Annual Fixed Charges and Operating Expenses —2 M.G.D. Production

Steam

Interest and Depreciation	$ 4,000
Oil, Maintenance, Etc.	500
Coal	4,000
Total	$ 8,500

Cost per Million Gallons—$11.60

Electric

Interest and Depreciation	$ 2,000
Maintenance	300
Power	14,000
Total	$16,300

Cost per Million Gallons—$22.50

tween steam and electrically driven pumping stations.

Power costs were computed from the regular tariff in force at the time. No saving in labor can be made with electrically driven units since the steam plant including boilers and pumps has been operated by one man per shift. New boilers were installed in 1925, so there was no need of improvement in the boiler plant, and no charge is made on this account in the comparative statement. It is interesting to note in this case that the total cost per million gallons pumped with steam equipment was approximately one-half of that for the electrical equipment. The steam station improvements were finally installed.

It is of interest to note that a few days ago the Water Department Engineers of the City of Pittsburgh decided to electrify one of its largest stations, which will have a capacity of 80 million gallons per day. Current is estimated as costing 6.5 mills per K.W.H.

While increasing use is being made of electrical power for actuating pumping machinery, fundamental principles still hold good and must be applied to every situation where the question of improving the pumping station comes up, in order that a sound decision may be made.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

The Trenton Sewage Treatment Plant

Notes on the Second Year's Operation

By P. N. DANIELS,

THE outstanding features of the second year's operation of the Trenton sewage treatment plant were, first, the absence of foaming, and second, the economical disposition of the very large quantities of sludge produced.

Trouble was experienced during 1927 with all of the twelve Imhoff tanks foaming during August of the year, the plant having been started in May. At a plant of this size, design capacity 25 millions gallons per day, with 12 tanks each 144 ft. by 33 ft., control methods in practical use for smaller installations cannot be economically adapted on a large scale, particularly seeding and lime addition by solution. As the tanks had to be started without seeding, the fresh solids-ripe sludge ratio could not be established, and as a consequence, severe foaming resulted as soon as digestion was well started. Liming was resorted to from the start and undoubtedly minimized the foaming period, but the application was not as efficient as it might have been due to the fact that the lime had to be sprinkled dry over the gas vent scum and then pushed or hosed down. The installation of apparatus for thorough admixture, either by solution or return pumping of sludge was out of the question as being prohibitively expensive so that undoubtedly a certain amount of the lime was wasted and had no effect. This was demonstrated by the fact that the sludge when drawn showed many particles of undissolved lime present throughout the mass.

After the foaming ceased, liming was continued through the winter to maintain a pH of 7.3, the amount used being 110 lb. per million gallons on the average. Contrary to expectations, the advent of warmer weather did not decrease the lime demand but increased it for the maintenance of a 7.3 pH, this possibly being due to larger increments of mash from the uptown illicit distilleries in amounts so great that from ⅓-½ of the grit was rye kernels, producing, of course, very acid conditions in the tanks. It has been the policy from the start of operation to use one of the twelve tanks as a control (we are functioning at about 75 per cent of design capacity) for the purpose of studying various operating procedures and the determination of the most economical routine.

This control tank was not limed after foaming had ceased and the pH dropped as low as 6.4, but it was found that digestion, although somewhat slower than the others, proceeded in normal fashion with production of very good sludge. Laboratory tests demonstrated the same facts, so starting the first of August, 1928, no lime was added to any of the tanks, the pH dropping in all to an average of 6.6. No foaming or other undesirable effects followed, the sludge output being consistently of excellent quality.

It is not to be inferred from the above that this disproves the beneficial effects of pH control at an optimum of pH 7.3-7.6 by the use of lime where required, as the circumstances at the Trenton plant are not the same as elsewhere. In the first place, the Trenton sludge, due to the iron content of the sewage (as high as 800 ppm.), digests far more rapidly than straight domestic sludge so that we can keep the fresh solids-ripe sludge ratio at a high figure, even with a sludge capacity per capita of about 1.98 cu. ft. This feature is fully discussed by Dr. Rudolfs in another paper. In the second place, if we can obtain the desired results, good sludge digestion without disturbance of sedimentation efficiency by foaming, without the use of lime, it is uneconomic to add lime merely as an accelerant to digestion. The time will arrive with growth of population and increased sewage flow when to postpone the necessity of plant additions, it will probably pay us to expand our sludge storage capacity by more efficient digestion using lime.

To maintain this high fresh solids-ripe sludge ratio, the hoppers are kept filled to the 18 in. zone and only small quantities of sludge are drawn at any one time. The flexibility of our sludge disposal system permits this, as explained later.

So far, April, 1929, the sludge digestion is proceeding normally with no foaming even though the weather has been unseasonably warm, and from all indications 1929 will be a repetition of 1928 as far as freedom from plant disturbances is concerned. The writer is not inclined to be over optimistic, however, when it comes to predicting the future course of events at a sewage treatment plant handling a wide variety of trade wastes and will qualify the last statement by stating that we do not anticipate trouble if the sewage constituents remain as they are now. Our distillery industry is apparently on the wane, judging by mash receipts, and also by newspaper reports of a widespread "back to the farm" movement on the part of our best bootleggers. This one item, the lessening of the mash content of the sewage, is bound to help a great deal towards the maintenance of proper digestion conditions.

Another factor which assists very much is the use of lime for pH control of corrosion at the Trenton water filtration plant, started early this year. The water supply, formerly below pH 7.0 at times, is now kept uniformly at pH 8.6—this is of course reflected in the pH of the sewage and the sewage sludge.

We started to lagoon sludge by pumping from the sludge alleys to a 12-in. cast iron pipe formerly used for scum removal. This method, while a great saving over the customary sand bed drying procedure, was bothersome in that the pump had to be kept going all the time to keep ahead of the sludge accumulation. Each sludge alley (six in all) has a 4-in. connection to a 6-in. water main and it was found that by a simple rearrangement of valves we could back up the sludge enough to give the head necessary to force the sludge to the lagoon by gravity. A few trials proved the feasibility of this method and the pumping was discontinued. At the present time only enough sludge is put on the sludge beds to supply the demand from farmers, florists and others, and the rest is lagooned. No trouble has ever been experienced from this lagooning due to odors, flies, or other causes. Approximately 500,000 cu. ft. of sludge (wet) is produced yearly, per cent moisture around 89.5.

The summary of the year's activities follows:

Total flow for the year, m. g.	5,841
Average daily flow	16.0
Total expenditures	$51,000
Operating cost per million gallons gross	8.73
Operating cost per million gallons pumping	4.36
Operating cost per million gallons treatment	4.37

Acknowledgment.—The above paper was presented at the 1929 meeting of the New Jersey Sewage Works Association.

Valves and Hydrants

Their Distribution, Installation and Maintenance

By C. S. HOWARD
General Manager, Iowa Valve Co., Des Moines, Ia.

THE number of valves and fire hydrants in a distribution system is a field in itself, many consider, however that there should be a valve at least every 500 ft. in a mercantile section and at least every 1,500 ft. in a residential section and for reduced pressures, cross sectioned to permit free circulation and no dead ends. This is a somewhat ideal arrangement, but will be found extremely satisfactory from a maintenance standpoint, and efficient service.

Spacing of fire hydrants is usually a matter of local determination with due regard to be given to property to be protected and the saving of hose and pressure. The loss of head is estimated to be around 18 lb. per hundred feet of hose. Therefore, economy is often made in having too many rather than too few. Various rules are given: 200 ft. in mercantile districts, 500 ft. maximum anywhere.

Installation of Valves.—No valve should ever be installed without a record being made of the size, manufacture, location and cost of installation together with the date of last inspection and by whom made. We know of many systems in which the only record is in the memory of someone since removed or dead.

We know many towns in Iowa and other states, in which there is not a single record of any valve, and many in which the only valves are right outside the pump house. We know of one city in which a certain section complained of poor pressure. A new main was considered and engineers were hired. It developed that a large valve was all but closed on a supply main. Hence the necessity of records.

We also suggest here that no valve be operated by any other than an experienced man, who is responsible to either the company or fire department if a hydrant is operated.

Valves are usually made of cast iron, usually thoroughly tested to a hydrostatic test of 300 lb. factory and found perfect or they would not have been shipped. But in shipping it may have been subjected to very rough handling, so always be sure before putting a valve in the line to give it a hammer test. It may save time and money if the defect is observed before putting on pressure.

When flanged valves are used see that the fitter shows a little sympathy for the valve, and brings the pipe to the valve, not the valve to the pipe. It is not an uncommon practice for a fitter on a pipe line to use the valve bolts to draw up 2 in. or 3 in. of separation. He may get by but what about the valve when pressure is on, or if the pipe line sags months later?

When installing valves, care should be used to see that the gates are securely closed, especially with screw and flanged types; it not only keeps the dirt and grit out of the valve which might scratch the seats, but adds strength and rigidity to the valves against strain of screwing or bolting the flanges.

With screwed end types, see to it that the pipe is not too long. The pipe may ruin the valve seats. Also never permit pipe compounds to be put on the threads of the valve, only on the pipe, for if put on valve threads, it may be pushed into the valve and cause trouble and expense.

A bad practice with screwed end valves is to permit or allow the wrench to be used on the end farthest from the pipe. The strain and leverage of a long wrench may spring the valve body slightly, and thereby warp or ruin the seats. Rest assured it was all right when it left the factory; therefore, if trouble occurs, the chances are the wrench was not used on the side next to the pipe.

Packing of Valves.—Many valves are observed to leak around the packing after having been in service a considerable length of time. This is often due to lack of oil on the packing or the poor quality originally used. From our standpoint, we prefer and use a braided Italian hemp packing that has been boiled in paraffin. By adding a little graphite this seems to be durable, does not corrode the stem to any marked degree, and by adding oil to the stuffing box with a long-necked oil can once or twice a year or at the time of the yearly inspections, adds material life. Especially is this true in warm climates. As to how often a valve needs packing, seems to be a matter of how often it is operated as well as local conditions.

Maintenance of Hydrants.—I know of no better rules than adopted by New Orleans which are as follows:

1. Open a fire hydrant slowly, and steadily, and always enough to prevent any chattering of the main valve, even if more water is drawn than is required.

2. If the fire hydrant is to be left open, with pressure available for self-closing or other faucet, or valve, on its outlet, for intermittent use, open it slowly, until the hydrant is full open, then release the operating nut by one turn backwards. Where a hose bib or other connection is placed on hydrant, care must be used to see that rubber gaskets are placed under the nozzle caps.

3. Close a fire hydrant very slowly, especially as the valve approaches its seat, until it comes firmly to its seat, and then release tension on valve and stem by one turn backwards of operating nut.

4. After closing a fire hydrant, see that the caps are properly replaced over its outlets.

5. Do not allow a fire hydrant to run for gutter flushing after the flow in the gutter becomes reasonably clear.

6. Use no tools to operate a fire hydrant other than a close fitting five-sided wrench furnished by the Sewerage and Water Board. If wrench becomes worn, so that it injures the operating nut, turn it in and obtain a new one in its place.

In the city of Akron, O., which I believe was the first city to put the hydrants in charge of the Fire Department, men are regularly sent from each department to inspect, operate and report the condition of each hydrant. No one is allowed to open a hydrant, but a fireman who is available for duty when called by contractors, etc. His time is then charged in the service by the water company.

In these days of automobiles, trucks and wild drivers, every fire hydrant should have a valve between it and the main. When a line has 80 lb. or more pressure and the hydrant is broken and spouts, of what use is a valve set directly in front of the hydrant. You can't get at it to close it off. Therefore, have the valve in the street not inside the curb or next to the hydrant.

Inspection of Hydrants.—Hydrants besides being systematically inspected at least every spring and fall should further be inspected after use, during the winter by a competent man, familiar with its construction and operation.

Every hydrant to be properly installed should rest on a solid stone or concrete base preferably broad at rear and have coarse gravel, bricks or the like, but no ashes, dumped around the base, then on top of this, straw should be placed. The reason for this straw is that in back filling by water the straw collects and prohibits the dirt from packing into the gravel and thereby permits ready drainage from the hydrant. Many cities connect every hydrant drain with the sewer. Where roots are liable to creep into the drain barrel of the hydrant, it may also be desirable to dump rock salt or copper sulphate in with the gravel. I have seen hydrants completely put out of commission because of roots.

However, salt in certain soils is very hard on cast iron so care should be used to prevent its coming in contact with the iron. For this reason, use of copper sulphate is strongly urged, although more expensive.

Hydrants, if properly installed, used and inspected, should last for years, for they generally wear out from abuse rather than use.

Acknowledgment.—The foregoing is an abstract of a paper presented to the second annual Iowa Water Works Conference.

The East Side Sewage Treatment Plant of the City of Topeka, Kan.

Exemplifies Many of Recent Developments in Sewage Treatment Practice

By CHARLES A. HASKINS
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THE East Side sewage treatment plant of the City of Topeka, Kan., now under construction, is of such a type that a description of the features of the plant will illustrate many of the recent developments in sewage treatment practice. This plant is designed to serve a population of 54,000 with an average daily sewage flow of 5.4 million gallons. Part of the sewer system is on the combined plan, but the bulk of the storm water will be bypassed directly into the Kaw River. The dry weather flow of the existing outfall sewer will be collected by an interceptor and conducted to a pumping station, from which it will be pumped through about 500 ft. of 30-in pipe to the treatment plant.

This plant is being built for primary treatment only, though it has been so arranged that activated sludge units can be added in the future. It is of the separate sludge digestion type. The units of the present plant include a bar screen, grit chamber, two 70 ft. square settling tanks, two sludge pumps, two 65 ft. circular sludge digesting tanks of the closed type, 28,800 sq. ft. of sludge beds, and a general building which houses the sludge pumps, the sludge heating equipment, the bar screen, and the grit chamber mechanism. The building also provides office laboratory, garage, shop. and storage space, and toilet conveniences for the operators.

Bar Screen.—At the plant the sewage will pass first through a bar screen having ½-in. openings. This screen is of the Dorr type, mechanically cleaned by a revolving rake arm, the screenings being deposited on a perforated drainboard. From this drainboard the screenings will be hand raked at intervals into a galvanized iron chute and will fall by gravity into a gas fired incinerator located on the floor below the screen unit. The incinerator may be run continuously or intermittently as the volume of screenings requires. Both the screen and incinerator are housed in the general building.

Grit Chamber.—After flowing through the screen the sewage passes into the grit chamber. This grit chamber is of a type very recently developed by the Dorr Co., and is known as a detritor. The detritor consists of two essential parts, a settling tank with grit collecting mechanism, and a washing compartment with grit cleaning and discharging mechanism.

The settling tank is of concrete 26 ft. square and with a water depth of about 2 ft. at normal flow. The sewage enters along one side through a series of gates which are made adjustable for the purpose of distributing the flow evenly over the tank, flows across the tank and out opposite side over a sharp crested weir running almost the full length of the side, and into an outlet channel, from which it is conducted through pipes to the main settling tanks. The grit collecting mechanism consists of four radial raking arms on the floor of the tank, suspended from an oscillating truss, one end of which is pivoted on a pier at the center of the tank, and the other end of which is propelled by a motor along a rail which runs around the periphery of the tank. In operation, the radial raking arms sweep the settlings toward the outside of the tank, and at a point on one side of the tank they are forced into a chute leading to the grit cleaning compartment. This cleaning compartment is an inclined trough built against one side of the tank proper. It is 15 in. in width and about 25 ft. in length. Since it is inclined, the lower part of it is below the water surface, while the upper part is above the surface. The cleaning mechanism consists of a series of reciprocating rakes hanging in the trough, and supported from above. These rakes move the settlings up the inclined floor of the clearing compartment to a discharge point at the upper end. During this movement up the inclined floor, a rolling action is imparted to the settlings, and since they are under water during the first part of the travel, there is effected a separation of the heavier grit and the lighter organic matter. The organic matter is conducted back into the tank through a bypass from the cleaning trough.

This unit is a very recent development, and information on actual operating results are very meager. The machinery, however, is practically the same as has been used for some time in mining and metallurgical operations and is well worked out as to details. A unit of this type, designed to handle 2.5 m.g.d. has been in operation for more than a year at Harrison, N. Y., and is removing 90 per cent of all grit over 100 mesh, with only 2.5 per cent of putrescible organic matter left in the grit.

The mechnical washing of the collected grit seems to be a decided advantage. The chief trouble with grit chambers is that, in order to catch the grit at times of high flow it is necessary to have very low velocities through the tanks at normal flow, and most organic matter is settled out with the grit. In the Topeka installation the velocities through the tank will vary from 0.2 to 0.4 feet per second, and some organic matter will no doubt be settled out, but will be later returned to the sewage from the washing compartment.

A novel arrangement has been provided for the removal of the grit from the site of the plant. At the upper end of the cleaning trough the grit is dropped into a hopper the bottom of which is about 5 feet below the surface of the water in the outlet channels of the main settling tanks. A six-inch pipe is laid from the outlet channel to the grit hopper, and a four-inch pipe from the bottom of the grit hopper to the outfall sewer, about 10 ft. below the hopper. Water will be allowed to flow from the outlet channel of the settling tank to the grit hopper, and flush the grit into the outfall sewer. The velocities of flow in the outfall sewer will be as high as those in the force main coming to the plant, so the sewage should be able to carry away all the grit it has brought to the plant.

Settling Tanks.—There are two settling tanks 70 ft. square and 8 ft. deep, equipped with Dorr traction type clarifier mechanisms. These mechanisms consist of radial sweeping arms on the bottom of the tank, suspended from an oscillating truss which is pivoted at one end of a pier in the center of the tank, the other end being propelled by an electric motor along a rail on top of the walls of the tank. The oscillating truss extends itself as the propelling mechanism approaches the corners of the tank, which are slightly rounded, and shortens again as the mechanism leaves the corner. The raking arms at the bottom of the tank sweep the settlings into a sump at the center of the tank, which is tapped by the suction pipe from the sludge pumps.

These clarifying tanks are designed for a 2½ hours' detention period. The sewage flows along one side of the tank in a channel designed to keep a constant velocity at all points, and enters the tank over weir plates extending over about 70 per cent of the width of the tank. After flowing across the tank it discharges over similar

weirs into an effluent channel leading to the outfall sewer. These weirs are in 6-ft. sections and are all adjustable.

In an effort to prevent any accumulations of floating matter on the surface of tanks, it was decided to omit all baffle walls, leaving an unobstructed water surface from the inlet to outlet. It is possible that there may be some circuiting or streaming effect across the surface of the tanks, in which case provision is made for the installation of baffles.

Digester Tanks.—There are two circular digester tanks, 65 ft. in diameter and 23 ft. deep, equipped with Dorr sludge agitating mechanism. The tanks are designed to provide a sludge capacity of 2.5 cu. ft. per capita. The floors of the tanks slope slightly toward conical sumps in the center. From these sumps 10-in. sludge lines lead to the sludge beds, and 6-in. suction lines lead to the sludge pumps in the building. These suction lines are provided so that the sludge in the tank may be circulated by pumping.

The sludge agitating mechanism revolves on a central shaft suspended from a truss bridging the tank, and consists of radial scraping arms for stirring the sludge at the bottom of the tank, and radial arms near the top of the tank for keeping the scum broken up.

An overflow is provided for carrying off some of the supernatant liquor in the tank when fresh sludge is being added. This overflow leads to an outlet beneath the surface of the water in the detritor tank. Means are also provided for drawing off any scum which might collect in the gas domes.

These tanks are equipped with concrete covers and gas domes for the recovery of the gas formed by the digestion of the sludge. The gas is piped into the general building where some of it is used in the incinerator for burning screenings. The bulk of the gas, however, will be burned in water heaters and the hot water circulated by pumps through pipe coils inside the digester tanks for the purpose of keeping the digesting sludge at a temperature favoring rapid digestion. The building will also be heated by the hot water. A daily production of about 30,000 cu. ft. of gas is expected when the plant is loaded to the designed capacity.

Sludge Pumps.—The two sludge pumps, for pumping the settlings from the clarifier tanks into the digester tank, are located on the main floor of the general building. They are diaphragm pumps of the Dorr type capable of handling 50 gal. per minute of 95 per cent moisture sludge each. Six-inch suction lines lead from the bottom of each of the clarifier and digester tanks to the pumps and 4-in. discharge lines lead from the pumps to the tops of the two digester tanks. These suction lines come together in a header located in the sub-basement of the building directly below the pumps. The suction and discharge pipes are so arranged that it is possible to:

1. Pump from either clarifier, with either pump, and discharge into either digester tank.

2. Pump from the bottom of a digester tank into the top of the same tank.

3. Pump from the bottom of one digester into the top of the other digester.

4. By an easily completed cross connection, it is possible to flush out any of the suction or discharge lines with city water under pressure.

5. All the suction lines enter the basement and terminate in wye branches, the branch of the wye leading to the suction header and the straight part being capped with a blank flange. By removing these flanges it is possible to rod out any of the suction lines, as they are laid perfectly straight.

Considerable thought was given to the layout of this piping and it is believed that an arrangement has been obtained which will allow of considerable flexibility in the operation of the various units of the plant.

Sludge Beds.—There are no unusual features about the sludge beds, but it is believed they are in line with the latest practice. There are 8 beds each 30 by 120 sq. ft., grouped together, providing 0.5 sq. ft. per capita. The sludge lines leading to the beds are so arranged that the sludge from either of the two tanks can be discharged on to any one of the eight beds. The filtering material consists of 6 in. of sand and 12 in. of crushed rock underdrained by lines of 4-in. tile at 5 ft. centers, laid with open joints. For removing the dried sludge, an industrial railway with push cars is provided. A main line is laid along one end of the battery of beds, with a turntable and stub track leading into each bed. Final disposal will be made by filling in several acres of land adjacent to and 10 ft. below the general level at the plant.

Appearance.—Since the plant is located adjacent to a residence district an effort was made to effect a pleasing appearance. All units are so arranged that they are symmetrical about the center line of the plant, and the earth grades and drives have been worked out so as to set the structures off to best advantage. There will be no overhead wiring about the plant, it all being carried in undeground conduit. When the plant is completed an effort will be made to get the city to beautify the grounds with grass and shrubbery.

Odor Control.—In the design of both the pumping station and the plant, the question of odor control was very important, as both units were of necessity located very close to residence districts.

In the pumping station an attempt was made to prevent the settling out of grit and heavier organic particles in the wet well, which is usually a serious source of odors. The floor of the wet well is to be formed into well defined and fairly narrow channels, so that when the sewage is drawn down near the bottom it will flow in these channels to the pump suctions with enough velocity to scour the bottom clean. Arrangement is also made to chlorinate the sewage at the pumping station, in order to keep it in a fresh condition while it is passing through the plant.

At the plant all reasonable precautions are provided for eliminating odors. Screenings and grit which are removed from the sewage will be disposed of promptly and in an inoffensive manner. The settling tanks have been arranged to prevent, as completely as possible, the accumulation of floating matter. Baffles have been eliminated and all corners likely to collect and hold deposits have been filled in. The digesters are of the closed type, and all gas issuing from them will be burned. The sewage is conducted about the plant, not in open conduits likely to collect deposits, but in underground pipes. Hydrants are provided about the plant furnishing city water for flushing and cleaning.

The fact that modern practice makes for the better control of odors has been a real economic advantage at this plant. Had it not been possible to control the odors so closely the plant could not have been located at its present site, and the next available site is about a mile farther from the pumping station. The use of the farther site would have added about $50,000 to the cost of the force main.

Chlorination.—It will be necessary during periods of low flow in the Kaw River, to chlorinate the effluent from this plant for the purpose of relieving the load on the water treatment plant at Lawrence, about 30 miles downstream. The sewage will also be chlorinated at the pumping station for the purpose of reducing odors at the plant. Since there will be a considerable consumption of chlorine, it has been arranged to handle the chlorine in drums containing one ton, instead of the small 150 lb. containers. This will effect a saving of from 35 to 40 per cent in the cost of the chlorine, and also a considerable saving in freight. The advantages of using chlorine in ton containers are well worth considering in any case where a large quantity is to be used.

Acknowledgment.—The above is an abstract of a paper presented before the Missouri Water and Sewerage Conference.

Aberdeen, Wash., May Buy Local Railway.—Legal proceedings leading to the acquisition by the city of the Grays Harbor Railway, Light & Power Co. of that district have been authorized in a communication from the city council granting to Mayor H. E. Bailey power to employ special counsel and to proceed with the necessary steps to procure the facilities.

Ethics for Engineering Services

By NICHOLAS S. HILL, JR.
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UNQUESTIONABLY, one of the most gratifying changes which has taken place with respect to the engineering profession during the last century is the recognition of the fact that the engineer is not purely a technician, but that many engineers are endowed with broad common sense, judgment and executive ability. Whereas formerly men serving in public office, on national and state commissions, or selected as the executives of large corporations were drawn almost exclusively from the field of business and the legal profession, it is very common to see engineers selected at this date, and there is reason for this, for no training serves as well to fit a man for executive work, if he has innate executive ability, as the training of the engineer. The recent attempt, however, of engineers to push or promote the engineer for executive or public positions, just because he is an engineer, is in my judgment erroneous, because that is a matter of individuality. The engineer with the qualities and equipment necessary for an executive and with a leaning towards executive or public work will gradually emerge from the practice of engineering into executive fields, and will command the same respect and attention as a man of the same qualities and equipment who emerges from the profession of the law or medicine.

In saying this I do not wish to belittle the professional work of an engineer. On the contrary, there is a grave question in my mind whether the professional work of an engineer, although possibly it does not bring the same emoluments, is not equally as important and as meritorious as the work in the executive field. Notwithstanding this fact, the engineering profession must recognize that as the profession grows and this country is stabilized there is going to be a greater and greater demand for executive engineers, and the educators in our engineering schools should, in designing their courses, bear this fact well in mind.

Engineers as Voluntary Advisers.—It may be well in this connection to call attention to the pitfalls which await the engineer when he assumes the responsibility of a voluntary adviser in civic affairs.

When working by himself and entirely on his own initiative the engineer who takes up civic questions is likely to be cautious in his public utterances and to confine himself to fields in which his personal knowledge, experience and professional reputation qualify him to speak or write. On civic committees, however, the engineer is only too prone to go into fields outside of his own and presume to speak or write without authority. This is a mistake, and an injury to the profession, particularly in the event specialists are employed to advise with committees on which he may be a member. It is only in cities of considerable size, and not always then, that local engineers are available to deal authoritatively with highly specialized subjects. Whenever an engineer or engineering committee, not provided with funds to call in someone who is really expert on the subject in question, assumes the responsibility of giving advice, there is always a danger of serious error, and there is also the danger resulting from the fact that the average citizen is apt to think that an engineer is an engineer no matter what the questions involved, and because an engineer or group of engineers in their midst is willing to supply information and advice gratuitously it is quite unnecessary to engage engineers and pay them for detailed engineering services. The engineer can do no greater service to his profession than frankly to admit his lack of knowledge on specific questions. He does not hurt himself by so doing, for no engineer can be expert on all subjects. When an engineer serves on public committees which have to deal with technical questions he can perform no greater service than to advise his fellow citizens of the necessity of securing expert advice. The medical profession is far and away ahead of the engineering profession in this regard. The doctor does not hesitate to advise calling in a specialist and by so doing he does not feel that he is depreciating himself in the eyes of his patients. In fact, the very act of calling in expert assistance ennobles the profession. It leads the public to have confidence in the engineer and the engineering profession as a whole. The future development of engineering depends largely on an appreciation of the responsibility of the individual engineer when he accepts service on public committees. It is desirable that the engineer should be public spirited, but he may, unfortunately, do a great injustice to the profession unless he appreciates the necessity of expert advice.

Utility Management and Finance.—A great field of usefulness for engineers has developed with the growth of municipally owned utilities, particularly in the field of water works management and financing. The rapidly growing percentage of engineers on water works staffs is pleasing because it shows an increased recognition of the value of engineering in this field. The public water supplies of this country are in general municipally owned, but they have an enviable place among public utilities.

How are our public water supply systems to attain even higher standards than have been maintained in the past? The answer is: More efficiency in administration, finance and operation, as well as sound engineering design and construction. In saying this, the importance of sound engineering is not to be depreciated, for that is vital. What the water works of today needs most, however, is freedom from partisan politics and independent administration. Freedom from politics can be obtained by the education of the public and proper city charters which isolate the water department and treat it as a utility. The success of any business enterprise depends upon its conformity with the fundamental laws of political economy. The United States Supreme Court and other courts have held that when a municipality engages in the water business it conducts a commercial enterprise and is subject to the same rules at law as a private company engaged in the same business. The water department should, therefore, be maintained as a separate entity and be made responsible for the establishment of rates which will secure the revenue necessary, not only for its operation, but for financing new issues of securities necessary to meet the development of the service. All water revenues should be returned to the water department and applied by it to the needs of that department. In other words, the water works should be self-supporting. Water revenues should not be robbed for the benefit of other city departments and the water service thereby crippled. To rob the water department in this way is not only precarious, but is unjust to the water consumer, who should not have his water bill increased to ease taxes for sewers, pavements, or other purposes. Engineers as a whole, I think, recognize this principle, and the members of the American Water Works Association can do a great public service by helping to educate the public to an appreciation of the necessity of treating municipally owned utilities as private utilities would be treated.

The Engineer and the Contractor.—The laws of most states and municipalities require that public contracts should be awarded to the lowest responsible bidder. This, no doubt, is the outgrowth of the lack of public faith in the public officials of the past. Every one of you must recognize that serious trouble could be avoided and better work secured if municipal officials could call upon qualified contractors for special work, but, unfortunately, such dis-

cretion vested in official bodies has been abused in the past. Whether the abuse which would arise from allowing the municipal engineer to select qualified contractors for specific work outweighs the municipal losses sustained by the rule of awarding to the lowest responsible bidder is seriously to be doubted.

A great improvement in the integrity and honesty of municipal officials has developed in the last two decades, and everyone knows that the rule of awarding to the lowest bidder requires that the city officials be prepared to deal with the man who submits the lowest estimate for the work to be done, irrespective of his proficiency. As a result of this condition, it has been absolutely necessary that contracts be so drawn as to give the engineer the whip hand when he is forced to deal with unqualified or unscrupulous contractors. Many of the contract clauses which appear excessively harsh are a direct reaction from this method of letting work.

The engineering profession, by upholding a high ethical code in its membership, can re-establish the public confidence in city officials, and by so doing make it possible to deputize to the city officials the discretion necessary to secure competent contractors for public works. If this were done, many of the contract clauses which are now found in all municipal contracts could be toned down. Such a modification would not only be of benefit to the municipalities, but would be a decided advantage to responsible contractors.

I am a hearty believer that the engineering profession can accomplish a great work by giving the contractor a square deal, and anything that tends in that direction will be beneficial not only to the contractor but to the profession and to the clients represented by the profession. What I desire above all things to bring to your attention is the failure of many engineers to give the contractor a square deal, to tell him fully and openly what they know of the conditions surrounding the work which he is to perform, as well as what they do not know, to the end that he may judge for himself concerning the risks and uncertainties of the proposed work.

I would also appeal to engineers to assume their own responsibility, to take the blame where they are to blame, and not to fall behind the broad but stringent clauses found in most public works contracts.

The reactions against these clauses are found in recent decisions of the courts. More and more the courts are finding that the mere writing of a clause in a contract does not make it binding, that a contract is based on equity, and that the contractor has rights as well as the owner. As a matter of fact, contractor and owner have a joint interest, namely, to do the work required as cheaply and as well as possible, and it profits no engineer to indulge in sharp practice upon the contractor. On the contrary, it profits him to help the contractor as much as possible. These principles have been recognized for years past, and yet how frequently we find the rulings of engineers on the interpretation of contracts and specifications overruled by the courts to the loss and detriment of the owner.

Such conditions not infrequently are the indirect result of competitive engineering bidding, and constitute one of the evils which follow in the wake of this practice. Engineers who fail to ask for the compensation necessary to enable them thoroughly to make preliminary investigations and prepare plans and specifications based on accurate data not only hurt the profession, but do an injustice to the contractor who bids on incomplete plans and specifications, and as a result thereof exposes his client to loss. May I ask this association to help in this regard?

Engineering Ethics.—It is pertinent to ask whether the ethics of our profession has developed to the same extent as has the practice of engineering in the last century. I don't know how you feel about it, but it appears to me that unless engineers unite and insist upon high ethical standards in the practice of their profession, it is doomed to ultimate commercialism.

It is perfectly true that as this country develops it becomes increasingly difficult, nay, wellnigh impossible, for the engineer to develop a private practice by hanging out a shingle and awaiting the advent of clients seeking his services. On the other hand, there is no reason why the approach of the engineer seeking new engagements should not be professional, dignified and reserved, and there is no reason why he should in any way lower the standards of his profession or do injury to a brother engineer in so doing.

A custom much to be condemned and which, if not corrected, will certainly react detrimentally to the profession, is to be noted. I refer to competitive bidding.

Nearly all of the professions recognize that it is unethical to compete with a fellow member for employment on the basis of professional charges by reducing his usual charges and attempting to underbid his competitors. Yet this is growing to be quite common among engineers.

Recently the city of Saratoga invited competitive bids for engineering and it was surprising to see that a number of engineers responded. A year or two ago Los Angeles felt called upon to advertise for outside engineering work and to award it to the lowest bidder. Even the Port of New York Authority some time ago extended an invitation for proposals to carry out certain important bridge designs. It called for bids on price and time of delivery of expert engineering services, services involving a very high type of specialized engineering skill and trained judgment, in precisely the same way that one would ask for price and time of delivery on coal or brick. This, so far as I know, is the first time a responsible and well informed public authority has resorted to the bidding system of selecting a professional man to direct the expenditure of large sums of public money.

This is bad professional practice, the evils of which are sufficiently self-evident to require no argument or proof. It is difficult to see any justification for it, and engineers who have regard for their profession certainly should not help such practices by submitting bids for engineering services.

I am sure that the men of the old school of our profession would have scorned such a proposition, and I think it is up to associations like this to combat the tendency by making it apparent that members who participate in such practices are not welcome to the profession.

It may not be amiss at this point for our own edification to dwell for a moment upon some of the older men of our craft with whom as youths we were associated, and to recall the dignified poise of their bearing, the outward sign of an inward consciousness of right doing which resulted from long years of sacrifice to their calling, to remember their rugged, simple characters, their allegiance to accuracy and truth, and devotion to duty growing out of a love of their profession and the lack of desire for personal gain, and ask if the profession of today is actuated by the same high motives. I leave you to make answer.

Engineering Fees.—We find much complaint among engineers of the small remuneration which they receive. How can the engineer expect consideration from the public and a proper appreciation of his services when he depreciates his own services by failure to uphold the ethics of his craft? Conceive, if you will, of a body of lawyers submitting competitive bids for legal services, or a group of doctors bidding for the cure of a case of illness or for performing an operation. No one would dare approach a lawyer or a doctor on any such basis, and there is no more reason why the engineer should be approached in this way than the doctor or lawyer, and it will not be until the engineer has a full sense of his professional dignity and of the value of ethics in his profession that it will be recognized and respected as other professions are.

Acknowledgment.—The above is a paper presented June 20 at the 49th annual convention of the American Water Works Association.

Concrete Pavement Over Poor Subgrade at Port Newark, New Jersey

Unusual Design for Paving on Fresh Hydraulic Fill of Clay

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The principal reasons leading to the adoption of an unusual concrete pavement design in Newark, N. J., were:

1.—The character of the subsoil and underlying strata.

2.—The presence of surface water in quantity.

3.—The lack of time, limiting the operations preliminary to paving.

Due to the dearth of adequate and conclusive information on sub-grade preparation and the many advances made in concrete pavement, the developed design is a mixture brewed of theory, experiment, and experience.

History of Paving Site.—The 22,000 sq. yd. of pavement designed to meet the conditions enumerated, were laid in the spring of 1926 at Port Newark, in response to the sudden demand for streets imposed by the rapid port development. A brief history of the paving area, which fronts the ship channel and extends about 1,500 ft. inland, will provide a background for the description to follow.

Originally, the entire area consisted of a flat level expanse of salt meadow at a general elevation of 5 ft. above mean low water. An average tidal range of 4.7 ft. kept the soft, spongy humus habitually moist. In 1917, as part of a development started several years previously, this area was raised to an elevation of about 8.5 ft., using material dredged from Newark Bay. In 1921, additional hydraulic fill was placed to an elevation of about 12 ft. Compaction and settlement of the fill and underlying strata required still more material three years later in order to maintain the elevation of 12 ft. In 1926, there was, on an average, a 9-ft. layer of clay fill the surface of which was at an elevation of 11 ft. above mean low water.

A number of wash borings in the paving site, revealed material clearly defined, but varying in thickness. The bed-rock, about 75 ft. below the surface, is a sedimentary shale of the Triassic formation common to Northern New Jersey. The 50 ft. of material (clay and sand) immediately above it, is part of the post-glacial drift. Next above this is a 10-ft. layer of mud and silt deposited by the waters entering the vast lake or bay once covering the area. Topping this layer is 5 ft. of humus, the result of the growth and decay of centuries of salt-marsh vegetation. This original soil is now covered by an average 9-ft. layer of dense red clay, hydraulically placed. Possessing all the disqualifications of clay as a sub-base, this upper layer presents the principal problem for successful road construction. A secondary, but no less important, consideration is the plasticity of the layers just beneath.

Observations and Tests on Sub-Grade.—Some observations that directly or indirectly throw light on the character of the soil and sub-grade were made.

Water Content.—When the dredged material was pumped in, two features were noticeable. In the first place, most of the material was in a finely divided state held in suspension by the water, causing the fill to resemble a quicksand for months, or until the drying out was complete. In the second place, numerous rounded masses, "balled clay," came through the pipe line. On examination, the cores of these masses were found to be perfectly dry. These features in themselves are not unusual in dredging experience, but they typify the impermeability of the clay fill.

After the fill had dried out, it was hard, compact, and apparently impervious to water. A rainfall, however, converted the area into a veritable sea of mud, causing water to stand for some time and softening the soil thus immersed to a depth of from 6 to 12 in. Run-off and evaporation disposed of most of the water, restoring, in time, the former hard, dry condition. These alternate conditions of high and low moisture content, resulted in a considerable change in volume as was evidenced by the cracks formed in the drying out process. These "sun cracks" varied in width and depth, depending on the penetration of the surface water and on climatic conditions. Cracks, 1 in. wide and 8 in. deep, dividing the surface into numerous small polygons, were not uncommon.

It would appear, therefore, that little percolation, if any, takes place and that the ground-water level is not influenced by surface water. However, after a rainy period, a trench only 3 ft. deep shows seepage, whereas, in dry periods, 5 or 6 ft. may be excavated before ground-water is encountered. The water content of the soil, then, is affected to considerable depths by rain and melting snow and ice.

Behavior of Piles.—Two influences operate to make the soil unstable, the moisture which softens the surface layer and the plasticity of the under layers. For all building construction in the Port Newark area, pile foundations are required.

To attain a bearing value of 16 tons, it has been found that the average pile must be driven to about 18 ft. below mean low water. However, a wide range from this average is experienced. Numerous pile-driving tests have been made, but thus far no method has been found to predict the pile lengths required for the sites within the area. The minimum penetration may be to 12 ft. below mean low water in one place, while not more than 20 ft. distant, a maximum depth of 32 ft. will be necessary to reach solid bearing. Pile-bearing value is largely dependent on skin friction, yet from the road builders' standpoint these values suggest that the strata beneath vary to such an extent in thickness, moisture content, and physical composition, that they influence the surface stability even for light loading.

Results of Bearing Tests.—In an endeavor to determine just what reliance could be placed on the light load-carrying capacity of the soil, two bearing tests were made. These consisted in preparing a shallow excavation with a level bottom upon which several layers of railroad ties were laid, imposing an equally distributed load over 17 sq. ft.

Elevations were taken, as the initial loading was applied, at each of the four corners of the platform. A week later the load was almost doubled, and

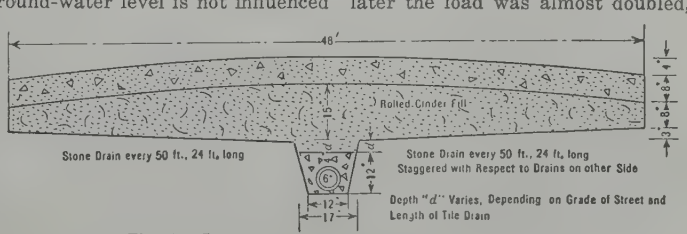
48'
Rolled Cinder Fill
Stone Drain every 50 ft., 24 ft. long
Stone Drain every 50 ft., 24 ft. long
Staggered with Respect to Drains on other Side
Depth "d" Varies, Depending on Grade of Street and
Length of Tile Drain
12'
17'

Fig. 1.—Cross-Section of 48 Ft. Concrete Pavement

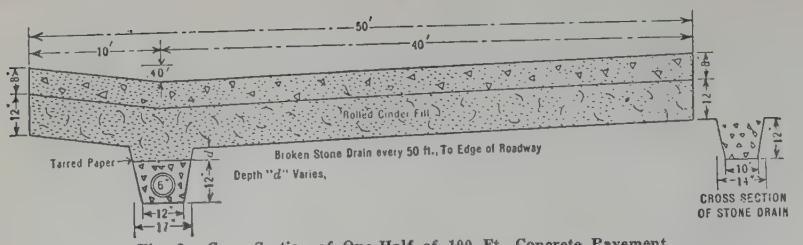

Fig. 2.—Cross-Section of One-Half of 100 Ft. Concrete Pavement

for a period of three weeks, observations were made to determine the settlement. In brief, the results of one test showed that a load of 174 lb. per sq. ft. caused an immediate net settlement of 0.008 ft. at the center; but despite the care taken to apply and distribute the loading equally, one edge of the platform had been raised and the other lowered.

After continuing to add to the load until 352 lb. per sq. ft. had been reached, the total settlement at the center amounted to 0.039 ft. When a week later a loading of 652 lb. per sq. ft. was reached, the settlement had become 0.172 ft. Without the application of further loading the platform settled progressively until at the expiration of the test period, of four weeks, a total settlement of 0.185 was noted. Meanwhile, the behavior of the corners demonstrated that even over 17 sq. ft. inequalities in soil-supporting power existed. In part, this was caused by the effect of moisture in softening the soil under the platform. During the test period, 2.14 in. of rain fell, the times of the heaviest precipitations being marked by the irregular settlement of the corners.

Soil Movements.—The movement of the top few inches of the clay, merely indicated by this test, was conclusively shown when cuts were made through a 3-ft. cinder railroad embankment placed on the clay fill. The clay surface under the center line of the track was depressed 6 to 18 in. and under the edges of the ties, 4 to 8 in., while outside the toes of the slopes it was forced upward 4 to 8 in. The extent of this movement was cumulative; that is, the deeper the clay depression became, the greater the volume of surface water collected and the more penetrating the moisture. Using the field test methods advocated by A. C. Rose,* Assoc. M. Am. Soc. C. E., the moisture equivalent of the subsoil was found to average about 50 per cent and the linear shrinkage, 7 per cent.

The influence of each of the two plastic layers just beneath the fill, was distinct. The meadow strata are very elastic and act as a cushion upon which the clay fill rests. Application of a light load to a sample of this spongy material results in considerable compression and a release of pressure causes almost complete restoration of volume. Filling over this layer compresses it as much as 5 ft. in places and slight additional settlement may occur for several years. The mud and silt layer, being in a semi-fluid condition, tends to flow in the direction of least resistance. The effect of this layer is to equalize pressures imposed on it. On a large visible scale this equalization occurred during the placing of the hydraulic fill. As the material rose in back of the bulkhead, acres of bay bottom, for ¼ mile, or more, seaward (formerly 2 and 3 ft. under water), emerged. This influence on surface structures cannot be disregarded, particularly when they are adjacent to the ship channel or bay front where the mud and silt layer is less confined. Imposition or removal of heavy concentrated ground loading, or the variable water loading due to tides, may operate, through this semi-fluid layer, to set up stresses in the clay crust.

Conclusions for Sub-Grade Study.—The foregoing studies and observations revealed so many indeterminate factors that a positive design, based on the usual assumptions, seemed impossible. The principal sub-grade factors that influence a pavement may be analyzed, however, and listed according to cause, effect, and remedy, as follows:

I.—Presence of Moisture in Clay Subsoil:
- (*A*) Cause:
  - 1.—Physical properties inherent in soil, such as,
    - (*a*) High moisture equivalent; and
    - (*b*) Finely divided condition.
  - 2.—Capillarity plus low elevation above sea level.
  - 3.—Long standing surface water, due to,
    - (*a*) Impermeability of soil; and,
    - (*b*) Irregular contour of surface.
  - 4.—Uniform strata of clay unbroken by veins or by adjoining strata of more permeable material.
- (*B*) Effect:
  - 1.—Lessened, variable, and uncertain bearing power due to plasticity.
  - 2.—Changes of volume due to excessive shrinkage.
  - 3.—Frost action.
  - 4.—Lateral movement of the topsoil on application of the loading.
- (*C*) Remedy:
  - 1.—Draining off the surface water.
  - 2.—Use of layer of fine granular material to:
    - (*a*) Decrease the height of capillary moisture;
    - (*b*) Quickly remove water from surface; and,
    - (*c*) "Cushion" the effect of frost "heaving."
  - 3.—Distribution of the loading over large areas.

II.—Movement of Sub-Grade Soil Layers:
- (*A*) Cause:
  - 1.—Additional compression of the meadow layer due to the added loading.
  - 2.—Further consolidation of the clay fill.
  - 3.—Equalization of pressures due to,
    - (*a*) Weight of tidal prism;
    - (*b*) Variation in the loading and of the surface.
    - (*c*) Deep excavations into the mud and silt layers.
  - 4.—Inequalities in the thickness of the layers.
- (*B*) Effect:
  - 1.—Permanent settlement.
  - 2.—Variable vertical movements.
  - 3.—Upheaval of the clay crust at planes of weakness.
- (*C*) Remedy:
  - 1.—Pile foundation for the pavement.
  - 2.—Use of substantial large sized paving units which would remain intact and keep their "riding qualities" while undergoing displacement due to subgrade movements.

Lessons From Existing Pavement.—In 1925 the construction and maintenance of roads and streets at Port Newark was transferred from the Bureau of Docks to the Bureau of Streets. At this time the only street in the south side area was a 36-ft. granite block pavement, 1,400 ft. long, laid in the spring of 1924.

This roadway consisted of 4 by 5 by 10-in. blocks laid on a 1-in. sand-cement cushion with joints of asphalt and sand, all on a 6-in., reinforced, 1:2.5:5, Portland cement foundation. Naturally, before the design and construction of additional streets, considerable study was given this one.

The base was reinforced with ⅝-in., deformed, square rods, on 6-in. centers transversely and 20-in. centers longitudinally, placed 2 in. above the bottom of the concrete. The pavement was laid on a 0.33 per cent grade and to a 4-in. crown, with one edge on the center line of the proposed 72-ft. width, the curb being about level with the surrounding ground. A depth of about 12 in. was excavated to provide for a layer of steam cinders. No particular grading or shaping of the clay under-grade was attempted, the spring rains creating a

*Proceedings, Am. Soc. C. E., January, 1928, Papers and Discussions, pp. 125 and 132.

deep layer of mud upon which cinders were placed and compacted as rapidly as excavation progressed. The result was a layer of cinders, 6 to 18 in. deep, spread and compacted over an irregular clay surface. No under-drains were placed.

Considering the subsoil drainage feature only, complete neutralization of the poor sub-grade was not accomplished. While it has been quite recently stated that "a poor sub-grade material can be transferred into a good sub-grade by the addition of sufficiently fine granular material or by the use of a layer of suitable granular material,"† this alone does not appear to effect the desired transformation at Port Newark.

It is true, the cinder course permits rapid percolation, keeps capillary water low, and acts as a cushion between the pavement and the volumetric and frost movements of the sub-grade; yet its efficiency is partly destroyed by the irregular contour of the under-base. Thus, when the clay sub-grade is recessed for the pavement, water will graitate to this trench and remain there, giving rise to lateral soil movement as found beneath the 3-ft. railroad cinder embankment previously mentioned. Irregularities of the clay, forming water-pockets, will aggravate the condition. Where a sufficient area is thus weakened beyond the ability of the concrete base to sustain the surface loading, failure might be expected. Examination of the pavement indicates that this may have occurred. The surface has many crosswise waves, the close spacing of the transverse reinforcing rods having doubtlessly prevented even more serious dish-shaped depressions. A more happy choice of reinforcing bar design might have still further aided in resisting the sub-grade forces.

As bearing out the assertion that sub-grade movements affect a pavement (equalization of pressure and other causes being ascribed), a comparison of elevations taken immediately after paving with similar readings taken in 1925, shows that, in general, a settlement (as much as 12 in. in some places) has occurred. A short section revealing a slight rise along one side and the irregular settlement over sections (as distinguished from localized areas), indicates the variable effect of sub-grade movements.

The relation between the location of such pavement movements and the many warehouses and other surface loadings has not been investigated. The fact that all buildings were erected subsequent to paving is, however, a starting point for such an investigation.

Under-Drains and Their Effect.—In the spring of 1926, when paving became necessary, the same conditions as existed for the 1924 paving were present, namely, a saturated top surface of clay, and standing surface water due to frequent rains. Two types of under-drains were used—a single arterial line in the center with laterals, for pavements of less than 50 ft. in width (Fig. 1); and a double arterial line, one under each gutter, with laterals, for pavements of greater width (Fig. 2). The arterial lines are 6-in. tile-drains (none extends more than 400 ft. before

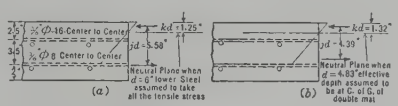
Neutral Plane when d = 6" lower Steel assumed to take all the tensile stress
(a)
Neutral Plane when d = 4.63" effective depth assumed to be at C. of G. of double mat
(b)

Fig. 3.—Analysis of Reinforced Concrete Longitudinal Pavement Section

entering a surface-water catch-basin or open ditch) laid to a 0.50 per cent minimum grade, recessed in the clay under-grade, and completely surrounded by broken stone. Tees are placed every 50 ft. from which broken-stone drains through the clay run out to the edge of the pavement. Tarred paper around joints, between the cinders and the broken stone, and other features common to such construction were included. In addition to the tile and stone drains, the clay under-grade was carefully shaped to direct water toward the arterial drains.

The value of these under-drains first showed itself when a dry clay under-grade was obtained upon which a layer of cinders could be carefully laid and compacted in place. After a pavement is laid their value is, of course, not so apparent. In view of the paradoxical results as to moisture content obtained under drained and under-drained sections of the Bates Test Road,‡ it might appear that tile drains fail to live up to expectations. The common assumption is that a tile pipe will drain a width of about six times its depth in clay soils, and fifteen to twenty times its depth in porous soils. When this assumption is made the fact that "time" is an important element is generally overlooked — particularly where clay soils are concerned; for, if drainage becomes operative only on saturation of the clay, then its value is nil. On the other hand, if a rate of flow through the soil is established shortly after the surface is wetted, then the system has merit.

Field studies would best determine the behavior of water on passage through a clay subsoil. However, as an index to what may occur, the experience of the writer in making the moisture equivalent tests will serve. Samples of the subsoil were gathered. While obviously the clay contained moisture, the masses were hard to break up and no dampness was visible; not even did the paper on which the samples were laid, become moistened. So little water was added to produce a "shiny" surface on the test samples of the clay that the writer decided to dry out the unused portions of several samples and thus, by weight, determine what moisture was originally present. The results showed that each sample in its original state contained about 20 per cent of water. If a mass of 25 lb. of such clay can be removed from the ground and exposed without drying out, it is evident that the most closely spaced tile drains will likewise fail to remove the moisture. While from the appearance of the clay this condition did not affect its bearing power, yet, evidenly, much more moisture would accumulate before "seepage" or drainage would begin.

Assuming, then, that the tile and stone drains are ineffective in themselves in draining water through clay, they still are important in removing the water brought to them by the sloping clay under-surface. To recapitulate:

1.—The porous cinder layer rapidly removes water from beneath the pavement;

2.—This is added by the herring-bone under-drainage system; and

3.—Water otherwise saturating the clay to disintegration is drained, as surface water, into the "broken-stone gutters."

Concrete Pavement Provided.—Consideration of various types of pavement finally led to the selection of concrete as best suited to the sub-grade conditions at Port Newark. The developed design consists of a 1:1.5:3 portland cement, reinforced, concrete pavement laid to a uniform thickness of 8 in. The double mat reinforcement is composed of ⅝-in. deformed round bars assembled so that the lower mat is supported 2 in. above the bottom of the pavement and the upper mat is separated therefrom by 3½ in. The lower members are spaced 8 in., both transversely and longitudinally; the upper transverse bars are on 8-in. centers, while the longitudinal bars are on 16-in. centers. The reinforcement extends to within 2 to 6 in. from the edges of the slabs, adjacent mats being properly lapped and the other usual practices observed.

All joints are vertical, with ¾-in. dowel-pins connecting the slabs across transverse joints. At all slab corners and angles, ⅝-in. bars, 6 ft. long, were bent outward in the form of a **U** (sides at an angle of 22 deg.) and placed in the top mat to combat corner failures. The specifications under which the work was performed, embody many of the proposals advanced by the committees on concrete pavement specifications of various technical societies. Daily laboratory tests checked the quality of the materials used and the strength of the resulting product. In

†"Recent Conclusions in Highway Research," by A. T. Goldbeck, Assoc. M. Am. Soc. C. E., Roads and Streets, March, 1925, p. 458.

‡"Tentative Conclusions on Design of Concrete Surfaces," by Clifford Older, M. Am. Soc. C. E., Roads and Streets, May, 1924.

the field, the slump test was used to control the consistency of the mix.

In scrutinizing any concrete pavement design, examination in the light of recent investigation is desirable. Each feature of this design will be so considered.

The 1:1.5:3 mix, with trap rock as the coarse aggregate, appears to represent the greatest strength and the least variability for road-building purposes. Accelerated wear tests conducted by the U. S. Bureau of Public Roads reveal that a 1:1.5 mortar with trap-rock aggregate provides one of the most resistant surfaces to abrasion.§ It is particularly fitting that this mix be used at Port Newark where heavy trucking is the principal class of traffic.

Students of recent development in design will be inclined, no doubt, to view a uniform thickness as a less advanced feature than the remainder of the design. It is usually assumed that a wheel load 3 ft. from the pavement's edge will do no damage. This being the condition at Port Newark, there is no reason for increasing the thickness of these pavements. Traffic is inclined to avoid the edge (on the 100-ft. streets) due to the depressed gutter lines, and likewise on the 48-ft. streets, due to the adjacent poles or other like features.

Recent studies¶ made public by the Highway Research Board of National Research Council, show that by increasing the reinforcement, a reduction in cracks is obtained more economically than by increasing the concrete thickness. Specifically, 170 lb. of bar reinforcement per 100 sq. ft. (50 per cent each way) causes a reduction in combined transverse and longitudinal cracks equal to an added 2-in. center thickness of concrete. In the design used at Port Newark there is 169 lb. of reinforcement symmetrically placed, the added alternate transverse bars in the upper mat making the total reinforcement 198 lb. per 100 sq. ft. It would follow, then, that the effectiveness of at least 2 in. of added concrete is obtained with respect to crack reduction.

Furthermore, the report states, for equal weights of reinforcement small bars closely spaced are more effective in minimizing crack development than larger bars. At Port Newark with ⅜-in. bars, 8 in. apart, it is hoped that a proper distribution has been achieved.

A pavement slab design cannot be analyzed with as great a degree of certainty as the usual floor-slab, yet there are reasons why the same kind of an analysis may be applied. It may be desirable, for example, in a comparative study, or in determining the capacity of the slab to bridge newly back-filled utility trenches; or as in the present case, in indicating the extent to which sub-grade failures will be harmless and in suggesting the possible piling required where total sub-grade failure is expected.

Computation of Strength. — Where only occasional sub-grade failures are expected, pavement slabs are not designed to carry their loads entirely unsupported since such a course would be both extravagant and unjustified. At Port Newark, localized areas of non-support might possibly occur due to partial disruption of the drainage system or minor settlements attendant on the movement of the underlying strata. When such areas do occur, the worst possible condition will not be 36-ft. slab supported at its ends only, since such a condition would pre-suppose exceptionally high bearing value for the sub-grade immediately adjacent to the "failure" and the ability of the dowel-pins to withstand the resulting shear. Instead, some indeterminate lesser area of non-support will generally develop, and then the slab, as a unit, will settle to a new bearing. Impact, inertia of the slab, and the many other factors, however, may operate to cause failure of the slab before it can adapt itself to the new plane of support.

As pavement slabs are used for years following their initial failure and as so many variable and uncertain elements preclude an accurate mathematical analysis, it is not so much the "safe" carrying capacity, but the ultimate carrying capacity, that is desired. For this purpose it is proposed to use 1,500 lb. per sq. in. as the "yield point"** of the 1:1.5:3 concrete; 40,000 lb. per sq. in. as the yield point of the steel; and $n = 12$.

Taking a longitudinal section of the slab, 8 in. wide, and analyzing it as a continuous beam by straight-line formulas,†† and neglecting for the present the upper mat (Fig. 3(a)):

a_s=0.1105 sq. in.
p=0.0023
k=0.2089
j=0.9304
kd=1.25 in.
jd=5.58 in.
M_s=24 643 in-lb.
f_c=880 lb. per sq. in.

An examination of Fig. 3 shows that the upper steel falls below the neutral plane.

Treating the entire steel system as taking the tensile stress in the beam at a depth equal to the distance of its effective center of gravity below the surface (Fig. 3 (b)), then

d=4.83
a_s=0.1658
p=0.00429
pn=0.05148
k=0.273
j=0.909
kd=1.32 in. (or 1.18 in. above the top steel).
jd=4.39 in.

$M_s = 27\,370$ in-lb. $= \frac{27\,370}{12}$ ft-lb.

f_c=1 260 lb. per sq. in.

Using $M = \frac{w l^2}{12}$ as for a continuous beam,

$$\frac{w l^2}{12} = \frac{27\,370}{12}$$

or,

$$w l^2 = 27\,370$$

Then, if, w=500 lb. per sq. ft.=333 lb. per running ft.,

$$l^2 = 82$$

or,

$$l = 9 \text{ ft.}$$

Thus, a load of 400 lb. per sq. ft. in addition to the weight of the slab may cause failure due to bending stresses, when the unsupported area has a width equal to that of the slab and a length of 9 ft. The analysis of a transverse section in a like manner will reveal a greater resistance to failure because of the additional steel in the top mat. A cursory examination shows that a concentrated wheel load of 7 tons will probably cause failure of the slab over an unsupported area the width of the slab and about 4 or 5 ft. long.

Where negative bending moments occur, the top steel should take the tensile stresses in the upper part of the slab. Failure under such a load will be perhaps more frequent (due to the position of the steel below the surface) than that caused by a positive moment.

When it is considered that the deflection of a slab under loading may add sub-grade support, and that with a smooth concrete surface, impact is kept at a minimum, the Port Newark slabs may be said to possess a relatively high resistance to failure—but should failure occur, a separation into rather large square sections will result, with the steel stressed beyond its yeild point, but still linking the sections together.

If a pile foundation is adopted to replace efforts at under-drainage, it will be necessary to re-design the slabs, decreasing the size and increasing the reinforcement in order to transfer the surface loading to the piles. Use of 6 by 7-ft. slabs, 8 in. deep, with about 270 lb. of steel per 100 sq. ft. and rows of 30-ft. piles, 8 to a "bent," with the bents 6 ft. apart, might be the principal elements of a possible design adopted. Whether the use of the Compressol System would be as suitable and more economical has not been investigated as yet by the Newark Bureau of Streets.

Comparison of Paving Costs.—Itemizing the approximate actual cost per square yard of both types of pavement and under-drainage laid at Port Newark, and estimating the probable cost of a pile-supported pavement, the results are as follows:

Granite Block (Actual Cost):	
Pavement on 6-in. concrete base (including 6 in. of excavation)	$ 7.38
Reinforcement (about 31 lb.)	1.40
Excavation (average)	0.70
Cinder fill (average)	0.90
Average cost per square yard	$10.38
Reinforced Concrete (Most Recent of the Three Contracts Let):	
Pavement complete	$ 3.57
Excavation (average)	0.84
Cinder fill (average)	1.60
Tile-drain (average)	0.20
Stone-drain (average)	0.40
Average cost per square yard	$ 6.61

§"Researches on the Structural Design of Highways, by the United States Bureau of Public Roads," by A. T. Goldbeck, Assoc. M. Am. Soc. C. E., Transactions, Am. Soc. C. E. Vol. 88 (1925), p. 264.

¶Report, Highway Research Board, National Research Council, Vol. II, 1926, p. 12.

**See Bulletin No. 5, Structural Materials Research Laboratory, Lewis Inst., Chicago, Ill.

††Symbols and analysis follow the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, Proceedings, Am. Soc. C. E., October, 1924, Papers and Discussions, p, 1153.

Pile-Supported Pavement (Estimated Cost):	
Pavement slab	$ 4.50
Pile foundation	7.00
Cinder fill	1.60
Excavation	0.80
Average cost per square yard	$13.90

Leaving aside the cost of surface drainage, gutter curbing, etc., the reinforced concrete pavement used at Port Newark appears to be the more economical in comparison with the granite block, and the more likely to prove satisfactory. Should it prove to deteriorate rapidly, the more than twice as expensive pile-supported pavement may receive serious consideration as a substitute.

Results to Date.—As the pavement is of comparatively recent construction, no time-proven conclusions as to its effectiveness can be drawn. However, interesting observations have been made.

Sub-grade movement has occured and displaced the pavement, noticeably, at three locations. In all cases it is at slab junctions and has in no wise affected the integrity of the slabs. At the maximum depression, water 4 in. deep is pocketed. Since numerous track crossings prevented the adoption of steeper grades, relatively slight slab settlement causes these water pockets to form.

Examination of the tile-drain outlets during rains shows them to be carrying a considerable volume of water during and after such periods. What settlement has occured is believed to be due to the major movements of the under-grade layers and not to movements arising from moisture-laden subsoil. Check elevations recently taken over the pavement substantiates this belief in revealing, over considerable areas, elevations differing from those to which the concrete was originally laid. The ability of the slabs to withstand displacement of this character or adopt themselves to it, while under traffic, seems, thus far, to justify the design used.

Conclusion.—At present, considerable study is being given to subsoil problems. As heretofore, the actual service experiences will apply the final test to the various solutions advanced and will point the way to still further improvements. Where a more or less experimental or novel design is used, it is believed an account of the surrounding circumstances will be of interest to engineers confronted with similar subgrade conditions. No claim is made that the Port Newark pavement is the best design possible nor that it is entirely original, since the experience of others in the highway construction field has been freely drawn upon; but it is one in which the City of Newark reposed sufficient confidence to expand $148,000.

Acknowledgment.—The foregoing is taken from the Proceedings of the American Society of Civil Engineers.

Hydraulic Gradient

Its Use in Water Works Maintenance

By ELMER G. HOOPER
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THE hydraulic gradient is a most useful and singularly successful means for solving certain kinds of problems that come up in maintenance, but it is necessary to recognize its limitations in order to retain full confidence in it. I shall try to demonstrate by example later on in this paper the type of problem that may be readily handled and show how in one or two cases the method had to be supplemented by other means to complete the solution. First, however, I will ask you to bear with me while I go into hydraulic theory a little and try to interpret it in a way that is useful to the practicing water works man. Some of you may be bored because I am telling you something you already know, but I am sure there are others who have forgotten enough of it to make it worth while to refresh your memories.

The Hydraulic Gradient Theory.—The "Hydraulic Gradient" may be defined as a continuous line or connected series of lines following the horizontal meanderings of the pipe or conduit but at a distance above or below it equal to the height to which the water from it would rise due to pressure in the main, either positive or negative. In other words it represents the limit of height to which water from the main could be delivered at any point. A sloping gradient indicates flow; a sudden drop in a sloping gradient at any point indicates concentrated loss of head, as at a partially closed gate, an obstruction, or a change in diameter of pipe section if the gradient has a different slope following the drop. A gradient changing suddenly from a steep slope to a less slope without change of pipe diameter usually means a large concentrated outflow at the point of gradient change, though it may mean a flow from a very old pipe into a new pipe of the same diameter. A horizontal gradient indicates no flow or very little; when a flat gradient drops suddenly at a point and resumes beyond at a lower level it indicates a disconnection, a gate down or a complete obstruction. In all these the point at which the gradient breaks is the important one. A gradient that slopes too steeply indicates too much flow for that size of pipe or too much deterioration in the pipe to permit that flow; in any case a gradient that is found to be much steeper than it normally is usually means excessive draft, probably leakage.

The mathematical expression for the hydraulic gradient may be obtained by transposing Bernoulli's Theorem, which must be familiar to all who have studied hydraulics in recent years. The theorem may be written in the following form between any two sections of the main:

$$\frac{v_1^2}{2g}+\frac{p_1}{w}+z_1+h=\frac{v_2^2}{2g}+\frac{p_2}{w}+z_2+L.H.$$

where v represents velocity at the respective sections,
p represents gauge pressure if w is 0.434,
z represents elevation of the pipe at the respective sections,
h represents lift from pump if there is one between the sections,
$L.H.$ represents the sum of all losses of head between the sections,

and $\frac{v^2}{2g}$ is the height in feet to which the water would rise due to velocity alone; $\frac{p}{w}$ is the height to which the water would rise due to pressure alone if an open vertical tube were inserted in the pipe (the height of the gradient above the pipe at the point); z is the height of the section of pipe above a common datun; the losses of head are divided for convenience into those due to friction in pipe of uniform diameter, to bends, to expansions and to contractions of sections, and then summed up. If a common level or datun is used it may be seen that the term $(\frac{p}{w}+z)$ is the height of the gradient at the section above that common level, and that $(\frac{p_1}{w}+z_1)-(\frac{p_2}{w}+z_2)$ is the drop of the gradient betwen the two sections. If we transpose Bernoulli's equation to produce this form we will have the following:

$$\left(\frac{p_1}{w}+z_1\right)-\left(\frac{p_2}{w}+z_2\right)=\frac{v_2^2}{2g}-\frac{v_1^2}{2g}+L.H.-h$$

meaning that the gradient drops due to loss of head, rises due to lift of the pump, drops if the velocity increases and rises if the velocity decreases. For practical water works purposes outside the pumping station all items except loss of head may be neglected and we may say then that the drop in the gradient is from loss of head. The drop in the gradient is therefore a measure of the efficiency of the parts of the system, and the nature and magnitude of the drop may be interpreted to tell whether anything is wrong, and may indicate what and where.

Application of the Gradient to Practice.—To illustrate the application of the gradient to practice, I am drawing on my memory of experiences in the service of the Department of Water Supply, Gas and Electricity, New York City, and because of the ten years or more that have elapsed since that service only a few outstanding examples are clear enough in my mind to

present them. As the cases are described you will no doubt say to yourselves, "why, he is only taking pressures." I shall fully agree with you, for it is the pressure reading converted to feet head and added to the hydrant elevation that gives the gradient elevation. You will appreciate then that it is only a common, everyday job that can be put to very useful ends when properly interpreted.

Case 1: An abnormally steep gradient, indicating excessive flow on a 12-in. main in 43rd St., Manhattan, between 5th and Madison Ave. A casual pressure taken on a hydrant on the north side of 43rd St., east of Madison Ave. seemed to be much lower than the district should have and this was verified as fact by pressures taken on mains in the same service not closely connected to the one suspected. This latter main had no connections to any other mains at or near Madison Ave. and 43rd St., though had there been any they would have been closed temporarily to permit flow from the two ends only, for the purpose of the investigation. The problem then consisted in determining and analyzing the gradient on a line 12 in. in diameter beginning at a 20-in. trunk main in Fifth Ave., extending east through 43rd St. across Madison Ave., where it changes to 6 in. in diameter continuing east to Vanderbilt Ave. at Grand Central Terminal, then north one block to 44th St. in which it turned west to connect with a 12-in. main in Madison Ave. There is a valve in 43rd St. east of Madison Ave. but west of the hydrant on which the first pressure was taken. This valve, a 12-in., will be designated as valve 1 for future reference. Valve 2, a 6-in., is on 44th St. east of Madison Ave. There were five hydrants on the line at which pressures were taken and converted to feet head. Elevations of these hydrants were determined by hand level readings from the most convenient street intersection whose elevation was known or could be assumed for datum, and the spacing of the hydrants was measured by pacing. By adding the pressure head to the elevation for each hydrant and plotting it to scale for the whole line a gradient was found consisting of two sections, each having a fairly steep slope downward from the ends of the main toward a common point about on the east building line of Madison Ave. and 43d St., near valve 1. In order to find on which side of this valve the outflow occurred, it was closed so that the supply could come from only one direction. The hydrant pressure dropped to less than zero, showing that the flow was from the east through the 6-in. line to a point just east of the valve, and that the amount of outflow was equal to the capacity of that line at least. For checking the location of the outflow and to obtain data to compute the amount, valve 1 was opened and 2 was closed and simultaneous pressures were taken for a new gradient.

Investigation showed that Grand Central Terminal improvements extended under the block from Vanderbilt to Madison Ave. east building line; that the main dropped several feet to pass between the floor of the basement and the ceiling of the sub-basement; that a 6-in. blow-off had been installed and connected with the sewer at that level in the west wall of the basement; that a special operating wrench for the blow-off gate had had to be provided; and that finally this gate was wide open thereby filling the sewer, a large one, more than two-thirds full. It was estimated from the pipe size and loss of head that about 4 m.g.d. was wasted and the sewer marks indicated it had been doing so a long time.

Another example quite similar to the above, except that it was on a submarine line, was taken as the subject of a brief paper read before a meeting of the New England Water Works Association in 1916.

Case 2: Gradient slightly lower than normal on a trunk main where pressure variation was usually slight; pressure reading was only about a pound lower than normal on a hydrant from a 20-in. main a few hundred feet east of its connection with a 48-in. main. This was on Pelham Parkway east of Southern Boulevard, the Bronx, on a main leading about 6 miles to City Island, having two 12-in. and one 8-in. lines at intermediate points normally feeding out toward Westchester village. When the gate was closed on first 12-in. feeder the gradient showed that the flow had been into the 20-in. main; the same thing was indicated at the other two lines showing a heavy draft toward City Island. At two points the 20-in. line divided into two 12-in. lines for under water crossings and the closing of these in succession affected the gradient in such a way as to show the supposed trouble to be still farther ahead and the gradient was becoming noticeably lower and lower. The heavy flow was finally pinned down to an 8-in. under water line about a mile long, which together with a 12-in. line supplied Hart's Island with water. When this crossing was shut off the local pressures went up from about 25 to over 40 lb. The slope of the gradient was used to determine the approximate location of the leak and by using a boat, which acted as a good aquaphone, the location was checked and buoyed for the repair crew. This leak or series of leaks (three lengths of split pipe not far from each other) was under 16 ft. of water at low tide. Less than a day was consumed from the time the suspicion was first aroused until the trouble was located, and for the most part by hydraulic gradient.

Case 3: Flat gradient followed by sudden drop. On one of the early days of 1917 when troops were being assembled and trained at Fort Schuyler, N. Y., water was suddenly cut off from the post. After considerable delay and late in the day word of the trouble was received. From the story of those on the ground the easiest and most obvious thing to produce results seemed to be pressure readings on hydrants outside the reservation since it was known there was no pressure within. The first reading taken showed a pressure slightly above normal, indicating at once a plugging of the line. Further investigation discovered a 6-in. meter with a strainer just inside the reservation and a very large eel tightly squeezed into the strainer thereby shutting off the entire supply. The trouble was located in about a half hour and remedied in another hour.

Another somewhat similar procedure discovered a rather unique plug in a section of 6-in. water line at 140th St. and East River which connects with an under water line to North Brother's Island. About 50 ft. of fire hose without couplings and tightly folded into the pipe by unbalanced pressure, produced by its own resistance to movement, completely shut off the supply of water to the island from the Bronx mainland, leaving the island dependent on another submarine line to Riker's Island and the mainland beyond. This was discovered when investigating the adequacy of fire protection for the island. The reason for the hose being in the pipe was learned later, but it would take too long to tell it here.

Under this case also would come the examples of gates closed and of pipes cut and capped. Such conditions were met with a number of times and it was not possible in any of the cases to tell which of the two were responsible until an excavation and an examination had been made. Because this was not an unusual or startling condition no particular one stands out in mind sufficiently clearly to be reproduced.

In the preceding paragraphs enough of both theory and of practice has been presented to provide food for reflection and it is to be hoped that some new and workable ideas have been suggested to some of you who have had the patience and the kindness to listen.

Acknowledgment.—The above is an abstract of a paper presented May 3 before the New York Section of the American Water Works Association.

Methods of Thawing Frozen Hydrants

According to a study of the methods used for thawing out frozen hydrants made by the New York State Bureau of Municipal Information, 25 municipalities use steam for this purpose, ten use electricity, seven use a commercial hydrant-thawing device, and five use salt, carbide or other materials. Two municipalities use alcohol in the hydrants to prevent freezing, and fourteen reported that they never experienced any difficulty with the freezing of hydrants.

Removal of Iron From Hard Ground Waters

Occurrence, Effects and Methods and Costs of Treatment

By R. L. McNAMEE

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IRON is found in solution in the ground waters of glaciated regions of the Middle West as ferrous carbonate. The soils contain iron as the ferric oxide (Fe_2O_3). Ground waters, especially in deeper strata, reduce the iron to the ferrous oxide (FeO). Carbon dioxide, common in hard waters, combines with the oxide to form ferrous carbonate. The ferrous carbonate is relatively stable under conditions such that the carbon dioxide is held in solution and oxidation does not take place. But when these conditions are not maintained and the water is exposed to the air as in open reservoirs or when drawn for use, a natural oxidation takes place and the iron reverts to an insoluble state and settles out or deposits upon many surfaces with which the water comes in contact.

Effect of Iron in Water.—The objectionable qualities of iron-bearing waters are common knowledge in Indiana. Plumbing fixtures become stained a reddish brown color where water drips from faucets. Fabrics acquire a yellowish discoloration in the laundering process. Certain industries find it necessary to eliminate the iron before using it. Under some conditions, dyes cannot be applied with waters having iron in solution. Woolens in the process of fabrication are discolored in washing. In the kitchen, also, iron has undesirable effects. Under some conditions it is impossible to brew tea of satisfactory taste. Certain vegetables assume disagreeable flavors when cooked in iron-bearing waters. When the Crenothrix is present, unpleasant tastes and odors are often present in the tap water.

These conditions, or some of them, are noticeable generally when the iron content exceeds 0.5 p.p.m. The United States Treasury Department Standard for drinking waters for use on common carriers in interstate traffic provides that the iron should not exceed 0.3 p.p.m.

Method of Treatment.—The artificial means of treatment employed to remove iron are substantially the same in principle as those natural processes which cause the precipitation and deposition of iron at the point of use. The treatment generally consists of three processes in series: aeration, sedimentation and filtration. Under certain conditions treatment with a coagulant is necessary in order to secure effective sedimentation. The aeration is the means by which the iron is chemically changed from the soluble to the insoluble form. The sedimentation is the means by which part of this insoluble iron is separated from the water. Some of it is in such a finely divided state that it will not settle within reasonable length of time, for which sedimentation basins may be provided. Filtration through sand is utilized to remove these finer sediments, for which purpose it has come to be an essential element of the treatment.

The removal of iron is not always so simple as this statement of procedure may indicate. The problem varies with the chemical content of the water and is seriously complicated with waters high in organic matter or bearing manganese in considerable amount.

Aeration.—The aeration of water is usually accomplished by the exposure of the water to the atmosphere under conditions favorable for its absorption. In a few instances, aeration has been provided by forcing air through the water by means of grids of perforated pipes or diffusers placed at the bottom of tanks through which the water passes. Aeration by such means is provided, incidentally, by the air lift pump, for which purpose this type of pumping equipment is to be preferred for iron bearing ground waters in some cases, over other types. Of all its applications the air lift pump is, of course, best suited to raising water from wells.

A variety of devices have been developed and are being used to facilitate the exposure of water to the atmosphere for purposes of aeration. Essentially they may be classed in three groups: sprays, falls, and contact trays. In many plants, a combination of two or more devices is employed.

Sprays are of several types, from simple orifices in pipes to more complicated whirling nozzles similar to those used for lawn sprinkling. An unique and efficient spray nozzle is that developed for use at the Sacramento water purification plant. The nozzle proper is formed as a bell-mouth facing upward. The throttling is secured by means of a conical casting which is floated by the head of water and which deflects the stream into a thin sheet over a wide radius. It operates well under considerable variations of head.

Sprays of one type or another are employed for aeration at Amesbury, Mass., Griffin, Ga., Lawrence, Kan., Leroy, O., Long Beach, N. Y., Middleboro, Mass., Selma, Ala., Stuart, Fla., and Wadsworth, O. The plant now under construction at LaPorte, Ind., will use sprays of the Sacramento type.

Falls in their simplest form consist of riffles, sloping surfaces sometimes provided with low baffles or ridges, over which the water flows in a thin sheet and thus exposes a large surface to the air. This type has the advantage of a low head loss but requires a comparatively large area. Some plants use a series of steps so arranged that the water has a free fall of about a foot between steps. This type requires more head than the riffles, but less area and in general will effect better aeration due possibly to the splashing of falls on the succeeding steps. Multiple splash trays are an elaboration of the series of steps. They consist of a number of shallow pans so arranged at levels one below another that the water overflowing the rims of pans on one level is caught on the pans of the next level below. This type secures the benefits of both the thin sheet of the riffles and the free fall and splash of the steps and is more economical of area than either.

Falls of one type or another are employed for aeration at Champaign, Ill., Excelsior Springs, Mo., Garretsville, O., Liberty, Mo., Red Bank, N. J., Sioux Falls, S. D., and Superior, Wis.

Contact trays are commonly built as a series of trays mounted one above another and filled with coke to depths ranging from 3 to 12 in. The water is piped to the uppermost tray and then trickles downward through the coke and drops through slots or perforated openings in the supporting tray to the next lower one. They accomplish aeration by causing the water to spread out over the surface of the material and absorb air which may freely pass through the shallow depth of material.

Contact trays are employed for aera-

Table I.—Reported Efficiencies of Certain Iron Removal Plants in the Middle West

Location	Treatment Processes*	Total Iron Raw p.p.m.	Total Iron Treated p.p.m.	Reference
Benton Harbor, Mich.	C S F	1.0–2.0	0.1†	(1)
Champaign, Ill.	A F	Practically complete removal		(2)
Leroy, O.	A P F	2.0	0.00	(3)
Memphis, Tenn.	A P F	0.60–0.75	0.03	(4)
Shelby, O.	A S F	1.6	0.10	(3)
Sioux Falls, S. D.	A S F	4.0–5.0	0.15	(5)
Wadsworth, O.	A S F	1.4	0.00	(3)
Xenia, O.	A S F	1.4	0.10	(3)

*A, aerators; P, contact beds as prefilters; C, coagulant; S, settling basin; F, sand filters.
†Experimental result.

tion at Liberty, Mo., Lodi, O., Memphis, Tenn., Shelby, O., Wausau, Wis., and Xenia, O.

Coagulation.—In certain cases, the iron, after aeration, seems to exist to a large degree in an extremely finely divided or colloidal state, such that it is very difficult to settle. In such cases, the sedimentation is materially improved by treating the water with some form of coagulant. The agents ordinarily used for this purpose are lime, which also serves to remove the carbon dioxide, or a finely divided clay which seems to benefit sedimentation by a sort of mechanical coagulation. Ordinarily in the middle western states the iron precipitates readily following simple aeration, so that the use of a coagulant is not necessary. The treatment of the water with lime is sometimes used, however, for the removal of carbon dioxide.

Sedimentation.—The separation of a large part of the insoluble iron carbonate resulting from the process of aeration is ordinarily practicable by allowing the water to flow slowly and quietly through basins of ample capacity. In waters containing much organic matter the use of a coagulant is necessary. A detention period of about six hours is usually sufficient to settle out the bulk of the iron sludge. The amount that will not precipitate within this length of time can be more economically removed by filtration.

When used following contact beds, sedimentation performs an important service in catching and settling out the sludge which occasionally sloughs off from the contact medium.

Filtration.—The process of filtration as applied for the removal of iron provides means for the deposition of the insoluble iron upon the surfaces so arranged that they may be cleaned at intervals as necessary. Two principal forms have been employed, contact beds and sand filters.

Contact beds are intended to supply a large surface area over which the water passes and upon which it deposits the insoluble iron particles. Where sufficient aeration is otherwise provided, these beds are not primarily designed to aerate the water. Under some conditions, they are operated submerged with water, a condition that precludes aeration from the atmosphere. In various plants, they serve both functions of aeration and deposition by contact in various relative degrees.

A variety of designs have resulted from the various uses of contact beds. The flow may be either downward or upward. The downward flow bed provides opportunity for aeration, controlled by partial submergence if desired. Upward flow beds must always operate submerged. The contact medium is usually coke but a great variety of materials such as shavings, wooden slats, bricks, and broken stone have been used with success. Provision must be made for flushing out the accumulated iron deposits at intervals. With some contact media, a positive washing arrangement must be provided.

The use of contact beds as a final treatment process is not always satisfactory. With high initial iron content the amount removed is usually high, but this process may leave too great an amount remaining in the effluent. In such cases, they are commonly operated as prefilters, followed by sedimentation and sand filters.

Contact beds are used at Amesbury, Mass., Brookline, Mass., Griffin, Ga., Leroy, O., Lowell, Mass., and Middleboro, Mass.

Sand filters, insofar as their service for the removal of iron is concerned, are simple strainers exposing large contact surfaces to the water. For such purposes alone, they usually remove iron more thoroughly than contact beds. But, in addition to the service in iron removal, the filtration process yields such important benefits in clarification and bacterial removal, that its use is warranted even at the somewhat greater first cost. Sand filters are more easily controlled and less subject to periods of inefficient operation than the contact beds. In general, the design of filters for iron removal is not greatly different from those for other purposes of water purification.

Plants of the following places employ rapid sand filters as a final iron removal process: Benton Harbor, Mich., Champaign, Ill., Freeport, Ill., Griffin, Ga., Iowa City, Ia., Leroy, O., Marshalltown, Ia., Memphis, Tenn., Red Bank, N. J., Selma, Ala., Shelby, O., Sioux Falls, S. D., Wadsworth, O., Wausau, Wis. The plant now under construction at LaPorte, Ind., will use rapid sand filters.

Efficiency of Iron Removal Plants.—A number of iron removal plants in the middle western states treating water generally similar to that from the ground water sources of Indiana are shown in Table I. The treatment processes employed are indicated and the iron content of both the raw water and final effluent is stated as reported by designing engineers or plant operators.

These data indicate that modern well-designed plants employing aeration, sedimentation or prefiltration and final filtration will reduce the iron naturally present in ground waters to amounts that cause no objection. Some of the data given resulted from experimental studies or early operation periods of new plants and it is probable that even better results have been obtained with these plants after they have become well regulated.

Cost of Iron Removal.—It is not possible to determine easily either the average investment cost or the average operating cost of iron removal plants. Variable conditions materially affect the design of plants and the cost of their construction. In many cases, existing works are utilized with considerable saving in new investment.

Table II gives a general idea of the investment usually required for iron removal plants. The data are as reported in current literature. Full details of the structures and equipment covered by these are not stated in all cases.

In all of these plants the filtration is provided by rapid sand filters of modern design which, in addition to their functions in the removal of iron, also clarify the water and eliminate bacterial pollution.

The data indicate that complete iron removal plants, employing the processes of aeration, sedimentation and filtration, and chemical treatment if necessary, will cost from $35,000 to $45,000 per million gallons per day of nominal capacity. Substantial reductions from these figures may often be secured where it is possible to utilize existing basins and structures to advantage.

Acknowledgment.—The above is an abstract of a paper presented at the 1929 convention of the Indiana Section of the American Water Works Association.

Table II.—Approximate Investments Required for Iron Removal Plants

Location	Treatment Processes*	Nominal Capacity m.g.d.‖	Investment in Plant	Investment Per Million Gallons Per Day	Reference
Benton Harbor, Mich.	C S F†	2.0	$199,134	$99,567	(6)
Selma, Ala.	A S F	1.5	65,000	43,333	(7)
Shelby, O.	A S F	1.0	35,000	35,000	(8)
Sioux Falls, S. D.	A S F‡	8.0	89,000	11,125	(5)
Wausau, Wis.	A C S F	3.0	125,000	41,667	(9)
LaPorte, Ind.	A S C S F§	4.0	124,000	31,000	

*A, aerators; P, contact beds as prefilters; C, coagulant; S, settling basin; F, sand filters.
†Includes additional processes for softening which materially increase cost.
‡Existing filtered water reservoir utilized as substructure.
§Existing settling basins utilized, but full capacity not required for iron removal.
‖m.g.d.—million gallons per day.

REFERENCES

(1) "Iron Removal and Softening Plant, Benton Harbor, Mich.," Eng. News-Rec., 91, 10, p. 378.
(2) "Iron Removal at Champaign, Ill.," by Frank C. Amesbury, Jr., Water Works, 66, 8, p. 330.
(3) "Iron Removal Practice in Ohio," by A. Elliott Kimberly, 2nd Ann. Rept., Ohio Conference on Water Purification, p. 147.
(4) "Operating Results at Iron Removal Plant at Memphis, Tenn.," by F. A. Mantel, Eng. News-Rec., 98, 21, p. 855.
(5) "The 8-M.G.D. Sioux Falls Iron Removal Plant," by F. G. Gordon, Eng. News-Rec., 91, 22, p. 882.
(6) Public Works, 54, p. 285.
(7) "Iron Removal at Selma, Ala.," by J. A. Fulkman and E. J. Taylor, Water Works, 66, 4, p. 157.
(8) "The Removal of Iron from the Public Water Supply of Shelby, O.," by Philip Burgess, American City, 30, 5, p. 468.
(9) "Iron and Manganese Removal at Wausau, Wis.," by Emil Flatter, American City, 38, 3, p. 125.

Protection of Water Supply Catchment Area

An Interesting Discussion of the Control of Watersheds

By JOHN F. SKINNER
Sanitary Engineer, City of Rochester, N. Y.

OUR first thought in connection with a watershed should be "conservation." We must conserve the water which it produces both as to quantity and quality. To do this we should preserve natural conditions, forest conditions and soil conditions, cleanliness and sanitary conditions, and also beauty and public opinion for if we are careful not to mar the landscape and not to make a point of excluding those who may enjoy its recreational aspects we shall go far toward securing cooperation in maintaining the cleanliness which is so much to be desired. To this end the watershed may be made a sanctuary for wild life; unusual types and specimens of trees may be marked, as in a park; roads may be constructed to make the entire territory accessible and recreational features may be stressed or at least allowed under proper regulations.

Sources of Water Supply.—If the water supply is from wells, less attention will be paid to the catchment area. Artesian wells which pass through impervious rocks or clay materials may reach water bearing sands which derive their water from distant sources and the water will be naturally filtered. Wells into limestone which receive through large fissures are often polluted. A study of the geology of the region may disclose the origin of the water and in some cases protection of the catchment area may be valuable. Shallow wells sunk into water bearing sand or gravel require protection in the immediate vicinity of the wells and the water from a greater distance will be naturally filtered.

When a supply is taken from a large stream or lake it will generally be economically inexpedient to attempt to protect the watershed; attention may better be devoted to the location of the intake, to minimizing local pollution and to subsequent treatment of the water.

For surface supplies from sparsely inhibited upland areas, considerable attention may be paid to protective measures and if the property is cheap, large areas may be purchased and controlled. Where the storage is small so that chance contamination may reach the supply quickly, people should be excluded as thoroughly as possible from the watershed; if, on the other hand, there is long storage the public may be admitted under proper regulations and restrictions, and the portion of the area farthest from the intake or diversion may be opened to campers, tourists and fishermen.

If the area is flat agricultural land with gentle slopes toward the main stream or lake, it may be sufficient to acquire a marginal strip of 100 yards or less along the shore of the lake or reservoir. In addition to this, highways within this line should, in general, be relocated further back and outhouses, hog pens, barnyards and refuse dumps should be removed from the immediate banks of tributary streams and garbage should be collected and treated or buried so that it will not reach the streams. The territory acquired should be policed and notices should be posted along the nearest highways, particularly at stream crossings.

If the area consists of steep, rugged land from which the water runs off rapidly, particular attention should be paid to villages and dwellings, to prevent crude sewage from washing into the reservoir. Of course, on such land, there is apt to be the minimum of inhabitants and the land will generally be cheap and readily purchasable.

If land is highly cultivated, it will have a larger population of men and animals and consequently be more subject to contamination.

Mr. Paul S. Fox, in his paper "Watershed Sanitation," which appeared in the Journal of the A. W. W. A. (July, 1928, Vol. 20, p. 50) states that the New Mexico code empowers the governing body of a municipal corporation to exercise control over a watershed for a distance of 5 miles above the point of diversion. He also writes: "On the watershed grazing was prohibited, which seems to be next to impossible. It was reduced, however, to a minimum and the improvement from a bacteriological viewpoint was remarkable. The restriction of recreational uses under controlled conditions was effected by ordinances, posting and policing."

Villages.—Small settlements on the immediate shores of the reservoir should be purchased and removed wherever possible. More remote villages and those too large and expensive to destroy must receive especial attention. Their wastes of all kinds must be excluded under the direction and at the expense of the water supply. In some cases, by discouraging public sewers and by inspecting and cleaning middens at frequent intervals, contamination may be avoided. Especial attention must be given to vaults in the winter when the ground is frozen for at such time if vaults are too full, their contents may overflow and reach the water at the first thaw. In some cases it may be necessary to construct a sewage disposal system to care for the sanitary sewage of the place. In all such cases a clear, well oxidized effluent should be produced and chlorinated.

Storm water passing through a village will necessarily carry impurities. Rough filtering or screening may be required and care must be taken not to locate a water works intake within the influence of such storm water stream.

It is better to purchase and remove cottages from the immediate shores of a lake or reservoir. Pending such action a palliative is an efficient pail system.

Use of Watershed.—Certain portions of a catchment area which it may be advisable to purchase, in order to control its uses and occupation, and which can be profitably farmed, may be leased to agriculturists giving first choice to the former owner or occupants. Such rental would be subject to specified conditions under the constant and immediate control of the water supply authorities. This will mitigate in a large measure the opposition of some who do not wish to move from the locality preempted.

Reforesting.—Without doubt, especially in a rugged country, a forest will afford the best cover for a catchment area of a surface water supply. Planting along streams will assist in preventing erosion of the land as well as formation of bars and deltas in the reservoir with the consequent loss of storage. It is well to maintain a bare strip a little above high water mark above which the littoral planting for possibly 100 yd. or more in width may well be of conifers, for leaves of deciduous tress would fall or blow into the water.

It has been suggested that when large tracts are to be reforested, nut trees and shrubs bearing berries be planted to furnish food for birds and other small wild life. Valuable woods such as black walnut flourish in some localities.

Many articles on the preservation of forests have stressed the prevention of erosion, the minimizing of floods and the relative constancy and uniformity of run off from forested as distinguished from denuded areas. These are all arguments for reforesting a catchment area and indicate that a wooded area will make a storage reservoir of

given capacity more efficient by flattening the irregularities of the supply curve. Such a forest should be planted with reference to the exposure and soil conditions best fitted for various kinds and varieties of trees.

Lanes about 50 ft. wide should be left clear as fire stops and where possible these should be so located that they may later be used as roads in lumbering, for it may be anticipated that with the increasing scarcity of timber these trees will, in the years to come, produce a valuable commodity and a considerable income.

Roads. — Good serviceable roads should be provided to make the territory accessible and, if the public is to be admitted, the municipality may treat it, in a measure, as a park and construct good roads, cutting vistas through the trees and running the roads to sightly lookouts where such scenic effects are available. Wayside springs may be developed as drinking fountains for travellers.

Camp Sites.—Where several miles from the point of diversion and limited by the local conditions, camp sites may be established either for automobile tourists or for those who may wish to remain for longer periods. These may be of various types, including parking space for those living in cars, tent sites and floors for those who bring canvas shelters, and forest cabins, more permanent in character, but in general housing a single party. Rustic comfort stations may be provided of the type used in the western parks and described in the U. S. Public Health Service report dated June 12, 1925 (Vol. 40, No. 24, pp. 1248-1258). At such a camp, a water supply should be sufficient to maintain the service and properly police the camp.

Fishing.—There has always been a difference of opinion on the safety and advisability of allowing fishing in a natural lake used as a reservoir. One position is that if boats and humans are excluded from the lake and its shores, they can not contaminate the water, hence they should be excluded and possible contamination avoided. Another group, nature lovers who enjoy the woods and streams and fishing, feels aggrieved at being excluded from their former haunts and are sure they have never harmed a lake as they themselves drink freely of it when on excursions in the neighborhood. It is difficult to see how fishing on the upper 5 miles in a lake 15 miles long where the water after two or three years storage is diverted at the lower end, can injure in any way the supply if proper sanitary measures are prescribed and enforced. The cost of service, maintenance, policing, etc., can be borne by small fees exacted for rentals, fishing permits, etc.

Hunting.—Shooting should in no case be allowed. Government reports state that small game and game birds are being exterminated. The remedy is in providing sanctuaries where they may find food and be unmolested. A large forested watershed incidentally provides such conditions while at the same time the absence of hunters reduces the fire hazard and makes the forest safe and more attractive to the great majority of visitors.

Bathing.—On sanitary grounds only it is probable that a limited amount of swimming in a lake or reservoir ten or fifteen miles away from the waterworks intake would not appreciably injure the supply but from aesthetic considerations bathing should be prohibited as most people are averse to drinking from another's bath tub.

Public Opinion.—The growth of cities and consequent need of public water supplies, and the increasing efforts of the population to escape into the country coupled with the ready means of transportation now at hand, presents a many sided situation which calls for broad consideration and a reasonable co-ordination of the interests involved. A certain public service company's engineer favored the entire elimination of flow over a beautiful waterfall because, based upon the traffic over a bridge below the fall, he figured the wasted water was costing about $5.00 a look. There are cases where an entire water supply might be properly utilized; it would be difficult, however, to convince the public that any private franchise or public use of Niagara power should be allowed to destroy the scenic attraction of Niagara Falls.

The same principle holds in a waterworks property. The supply may be assumed as a public necessity; the creation of the storage provision for compensation water to communities down stream and the protection of the catchment area should be hand in hand as a part of the cost of the proposition. It will usually require but a small additional expenditure to make the territory attractive and afford pleasure to many people.

If the public, made up of individuals, the same ones who eventually pay the bill, are shown consideration and afforded a beautiful forest retreat, distant views of the blue water reflecting sky and shore and a chance for a few of them to fish if they like, a pride will develop in "our waterworks," each one will become a booster and there will be the best possible co-operation in keeping things clean.

Watershed of Rochester, N. Y.—As an illustration of a well managed watershed, a small portion of which has been purchased, we may refer to the present catchment area of the municipal water supply, of Rochester, N. Y. The total watershed now in use is 66.2 sq. miles of which 48 sq. miles is tributary to Hemlock Lake, 12.4 sq. miles to Canadice Lake and 5.8 sq. miles to the Canadice outlet. Canadice Lake lies nearly 200 ft. higher than Hemlock Lake, and the outlet is a tumbling stream running through a quick watershed to the Hemlock outlet. From a low diversion dam in the Canadice outlet channel, a 5 ft. concrete conduit brings the Canadice water into Hemlock Lake from which the present conduits proceed to the city of Rochester about 390 ft. nearer sea level and 27 miles due north.

Hemlock Lake had a natural shore line about 15 miles long. For about 20 years, but little land was purchased and the cottages along the shore were served by a pail system operated by the city. In 1895-6, a strip 200 ft. wide from high water mark was purchased and other lands have been added from time to time. Last year the dyke across the foot of the lake was raised 5 ft. to furnish increased storage and considerable property at the head of the lake was flooded during high water. The total area owned by the city around and on the watershed of Hemlock Lake is 2,617 acres.

On Feb. 6, 1919, water was turned into Hemlock Lake from Canadice Lake. The land acquired in the Canadice Lake watershed amounts to 550 acres, and 350 acres have also been purchased in the Canadice outlet, making a total of 3,517 acres now owned on the catchment area. Patrol of the shores is maintained, and the washing of sheep in the lake, as formerly practiced, has been discontinued. Where formerly barn yards and heaps of waste were located on the banks of runs and ravines, buildings have been constructed elsewhere, partially at the city's expense and the unsanitary conditions thus abated. By closing a road along the east shore of Hemlock Lake a potential source of pollution was avoided. This was made possible by the co-operation of the local highway commissioner who had found this road difficult and expensive to maintain. When the cottages were removed there was no reason for the road, as it was paralleled by another and better road on higher ground.

Canadice water has always been chlorinated before its discharge into Hemlock Lake and since May 11, 1925, the entire supply from the domestic system has been chlorinated at Rush Reservoir, nine miles from the city. Taste or odor due to chlorination is not noticed in the water as the conduits discharge into two distributing reservoirs of a total capacity of 165 million gallons where there is at present over five days' exposure to the air. There is a large fountain in each reservoir through which about 25 million gallons pass daily during warm weather.

The city property at the foot of Hemlock Lake near the gate houses is landscaped and a picnic pavilion is provided and a grill upon which meat may be broiled. There is, of course, ample water supply, and comfort stations and parking space are provided. In addi-

tion to small parties and some organizations from the city, the place is frequented by organizations from the rural country round about. Its free use serves to create good feeling between the local inhabitants and the waterworks authorities.

In 1902 the city of Rochester began planting trees on the shores of Hemlock Lake. Since that time the work has been extended along the shores of Hemlock and Canadice Lakes and on other areas acquired on the immediate watersheds of these lakes. To date nearly 1,500,000 trees have been planted on about 1,250 acres.

Additional Watershed Proposed.—A project for increasing the water supply by a large addition to the present watershed through the construction of a dam in the Honeoye Valley has been approved by the New York State Water Power and Control Commission. The plan will increase the present Honeoye Lake from 4.5 to 15 miles in length and raise its normal surface 30 ft. The watersheds now utilized will be tributary to the new reservoir and form a part of the total area of 187 sq. miles. This may again be increased to 209 sq. miles by storaging water in a high parallel valley and bringing it into the reservoir through a 5-mile tunnel. The new project looks forward to an ultimate supply of 100 million gallons daily. The engineers who devised this plan were Harrison P. Eddy, Allen Hazen and Edwin A. Fisher, and in their report they say:

"A large amount of land will be required. This should be bought liberally to the end that the city may completely control its source of water supply, and hold it free from centers of population that will tend to impair its quality.

"The land to be submerged is mainly the bottom of the old lake valley which is now swamp land, uninhabited, undrained, more or less covered with forest, and not of great agricultural value. All the land to be flooded must, of course, be secured at the outset either by purchase or by eminent domain, and also a certain margin of minimum width around the lake. In addition to this, and somewhat optional, it is our recommendation that the city buy as far as it can at fair prices, large areas of land to protect the quality of the water. In some cases, buying farms that would be inconveniently situated with respect to roads will remove the necessity for building roads leading to them. The land to be submerged must all be secured before the dam is built, but acquiring other areas may extend over a long series of years.

"We believe that the marginal areas bought and held should be much wider than have been taken in the past, to the end that the great new lake to be now formed may be completely protected in its sanitary quality for water supply for all time."

It has been estimated that the land eventually taken will amount to between 30,000 and 40,000 acres. The southern portion of the territory is more rugged and excellently suited for forest. It is proposed to exclude the public from the shores of the northern part of the reservoir, while it has been suggested that the southern portion might be used more liberally while at all times being kept under careful supervision.

The elevation of the proposed lake or reservoir surface will be +830, while some of the country which it is proposed to acquire rises to elevation +2200. Beautiful views may be had from present and future roads. The farthest limit of the watershed is but 40 miles from the city as the aeroplane flies and the round trip by highway from Rochester around the reservoir may be accomplished through 90 miles of varied scenery in a few hours.

Aerial Survey.—For the purchase of so large an area and because of the difficulty and expense of surveying such rough and wooded country and mapping it in the usual way, an aerial survey and photographic map was decided upon. There were 529 original 8 in. x 10 in. negatives made at a scale of about 1,000 ft. per inch flying at 12,000 ft. elevation. These pictures will be "laid" and the map enlarged to a scale of 800 ft. per inch. Greater enlargements may be made of any details up to 100 ft. per inch. The weather was very uncertain, some re-flying was necessary on account of clouds, and it required from May to August, with the plane constantly ready for flight, to accomplish the few hours of photography required for the 205 sq. miles of area covered. In order to give scale to the map, the city has undertaken a first order triangulation survey of the territory, and has placed a series of visible ground marks at known locations on both high and low ground. In the pictures lot lines described in property conveyances are readily identifiable and a net consisting of these lot lines will be superimposed on the photographic map.

In this country a run, ravine, arroya or gully is colloquially known as a "gull." These gulls generally reveal themselves in the pictures as broad crooked lines of trees and shrubs. Forests have a mottled appearance due to tall and low trees while nurseries or plantings of our reforesting show a plain and uniform color due to the trees in the given area being of the same age.

In the protection of catchment areas, we should have a true map to show things honestly as they are. The treatment of the public in reference to the area should be just from every viewpoint. The water should be kept pure and the surroundings lovely as in nature. This will result in good reports of the system so that any virtue in the management will receive the praise deserved.

Acknowledgment.—The foregoing is taken from a paper presented at the Montreal Convention of the New England Water Works Association.

Detroit's $11,000,000 Airport

Construction is well advanced on the airport now being built by Detroit on a $6,000,000 site owned by the city. An additional $5,000,000 was voted at the November election. On the property already owned by the city, consisting of 250 acres in the northeast section of town, extensive grading and draining work has already been done. The first of several runways, 1,000 ft. long and 150 ft. wide, has already been constructed. The last of the concrete slab was placed on June 21. This concrete runway gives access to the southwest section of the L-shaped port and will be supplemented by others, affording take-off and landing facilities in all directions, under all weather conditions.

According to P. A. Fellows, city engineer, contracts have been let for the placing of 20,415 sq. yd. of concrete surface to be used as hangar aprons, taxiways and maneuvering space for planes taking on or discharging cargo. Much of this work is to border the combination exposition hall and hangar, a great steel and concrete building 1,000 ft. long and 200 ft. wide, the cost of which is estimated at $1,000,000.

In plan, the Detroit City Airport may be compared to the famous Croydon port at London, although when finished the Detroit plant will be far more elaborate and convenient. In its completed form, the airport will be featured by a wide esplanade leading motor traffic off of Gratiot Avenue directly to the Administration building, where passengers may buy tickets and obtain other travel services as conveniently as at the most modern railway terminals. Beyond the Administration building there will be a covered concourse where planes may be boarded in safety and comfort, without exposure to the weather.

The exhibition hall will flank the esplanade on the right; an equally large hangar will be located on the left. Every equipment for facilitating air traffic, day or night, is to be installed, thereby assuring both pilots and passengers the utmost in safety and regularity of service.

Four Massachusetts Water Properties Sold.—Community Water Service Co., through a subsidiary, Greenwich Water and Gas System, Inc., has acquired the water properties serving Dedham, Hingham, Scituate and Cohasset, Mass. The companies acquired are appraised at $4,805,900.

Prechlorination and Filtration

Experience at Plant of Newport News, Va.

By E. F. DUGGER
General Manager Newport News Water Works Commission, Newport News, Va.

OUR city is very fortunate in that the drainage area of our reservoirs is to a great extent uninhabited and covered with woodland, which gives a three-fold benefit:

1st. Contamination is minimized.

2nd. A uniform runoff.

3rd. The trees or woods serve as a wind break and by this means decreases evaporation.

There are two elements that prohibit deep storage in our section of the peninsula, first, the general low elevation of the land preventing the raising of the dams, and second, the danger of getting salt water from deeper excavations.

General Conditions of Supply.—We have three reservoirs and the one directly connected with the filtration plant, with a maximum elevation of 17.4, has a storage capacity of 844,000,000 gal., which without the normal yield from the surrounding watershed, will allow approximately 200-day supply based on our present consumption. With this number of days supply impounded, a great amount of sedimentation takes place in the reservoir.

Lakes or impounded streams such as we have are the natural primary settling basins, and with the extended storage in our lakes much of the matter in suspension has sufficient time to settle out in the lakes. This process, however, is of varying degrees of excellence, because of the effect of wind currents on the water, at times the silt or sediment in the reservoir is stirred up and again is put in suspension. On account of the flatness of the surrounding country, it is imperative to keep the springs and streams clear of leaves and sediment, as the water in these streams moves with such low velocity that sedimentation takes place to a great extent in them, and when the heavy rains come, unless the streams are clear, much of this sediment is washed into the lakes and considerable trouble arises from high color caused by tannic acid. As the result of systematic clearing of the springs and streams the water is usually very clear. The raw water average color is around 30, with an alkalinity of 85, turbidity of 10 p.p.m., and a bacterial count of 250 colonies per c.c. which makes a comparatively easy water to coagulate, settle and filter.

The introduction of coagulants in the raw water just ahead of its passage through the centrifugal pumps has resulted in a very thorough mixing of the water with the solutions.

Chlorine is first applied to the raw water in the suction line at the rate of from .3 to .4 p.p.m. prior to the application of alumina sulphate. This latter is applied at the rate of 9 to 10 p.p.m. The coagulation basin has a capacity of only 651,000 gal., but the rate of flow of the water through it is regulated by the use of baffles. The precipitate deposited in this basin has shown conclusively the great value of prechlorination. Before our adoption of this method it was not necessary to clean the basin more often than once in five or six months, but since we began prechlorination, the basin has done the work for which it was designed so much more effectively that it is necessary to wash the basin at least once every 30 days, even in the cold weather, else the precipitate becomes so heavy that it breaks up from the bottom and floats on to the filter beds. Previous to prechlorination the filter beds were compelled to do the work now done in large measure by this coagulation basin which necessitated excessive washing and continuous boosting.

After sedimentation the water flows from the basin by gravity on to eight rapid sand filters of 1,000,000 gal. capacity each, under which is located the clear water well with a capacity of 235,000 gal.

On Jan. 1st, 1923 we felt that our filtration expense was unusually large compared with the results obtained. During the year 1922 the annual output of the filter plant was 1,568,000,000 gal. of water, at an expense, which included the wash water, of $19,664 or $12.53 per million gallons. During this period from January through November we were using 22 per cent alum. But for the month of December, for experimental purposes, we used 17 per cent alum, and the floc obtained with this 17 per cent coagulant was far superior to that which we were obtaining with the 22 per cent, and this item alone meant a considerable reduction in our operating expense.

Results of Prechlorination. — In August, 1923, after the recommendation of A. L. Gammage, Consulting Chemist of the firm of Weston and Sampson, of Boston, Mass., we began prechlorination with the immediate result of a much finer and denser floc with a still greater reduction in the amount of alum. In a short time we also noticed a material increase in the length of filter runs, a decrease in the percentage of wash water and an increase in gallons of water filtered, and a material decrease in the bacterial count in the applied water.

Prior to prechlorination we had considerable trouble with our filter beds. At the end of practically every run cracks would appear in several places in the beds and in several instances the sand would actually pull away from the sides. In washing, hard spots would be visible over the bed which would necessitate considerable labor expense in breaking them up. This trouble has now practically disappeared and the filter beds have a smooth surface with very rarely a hard spot.

We use two independent chlorination plants at all times and this naturally gives us greater assurance of perfect results in the disinfecting process.

The long reacting period of coagulation basins and the chlorine absorbing capacity of the filter beds at most plants permit relatively large overdoses of chlorine without having free chlorine in the filter effluents. This is of practical value, in that when the rate of filtration is lowered it is not necessary to reduce the amount of chlorine applied as the beds will absorb all excess. In fact, the dechlorinating capacity of the filters makes the preliminary chlorination of the raw water comparable to superchlorination.

Comparison of Results.—Table I is a comparison of results in the filtration department for the year 1922, which was prior to prechlorination, with that of 1928.

Costs.—The total expense for the operation of the filter plant for 1922 as previously stated, amounted to $19,664.15 or $12.53 per million gallons. Total operating expense of the Filtration Plant for the year 1928 was $11,570.44 or a total cost of $7.65 per million gallons, which was a net saving in operating expense of $8,093.71 per year or $4.88 per million gallons.

In addition to prechlorination sufficient chlorine is also applied to the filtered water to give a residual of .20 to meet State Health requirements.

The average depth of our reservoir is 8½ ft. with a total flooded area of about 500 acres. With the warm climate the conditions for algae growth are ideal.

Ackowledgement.—The foregoing is an abstract of a paper presented at the First Virginia Conference on Water Purification and Sewage Treatment.

Table I

	1922	1928
Gallons of water filtered	1,568,851,563	1,511,951,662
Daily average	4,292,744	4,142,333
Total pounds of Alum	216,889.77	150,300.86
Total pounds of Chlorine (Raw)		10,518.08
Total pounds of Chlorine (Filtered)	5,863.22	4,083.64
Alum G. P. G.	.964	.69538
Chlorine G. P. G. (Raw)		.0487
Chlorine G. P. G. (Filtered)	.0261	.0189

	Raw	Treated	Raw	Treated
Color	0.	10.7	26	10
Alkalinity	61.83	57.2	71.09	63.53

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The Electromagnetic Theory of Air Circulation

In "Municipal News and Water Works," October, 1928, the editor outlined his electromagnetic theory of permanent and migrating cyclones. It was shown that there are 12 permanent cyclonic whirl centers, 6 in each hemisphere, 6 near the equator and three near each pole. The 6 great whirls in the northern hemisphere rotate anticlockwise, while the 6 in the southern hemisphere rotate clockwise. In the article above cited the rotation was erroneously given in the reverse direction.

Each of these 12 permanent cyclones has a corresponding anticyclone, for each ascending whirl bends over and descends, forming an inverted U. This inverted U also characterizes the migrating cyclones that cause our storms.

The editor finds that the three permanent cyclonic whirls whose centers are near the arctic circle, descend as anticyclones somewhat north of the Tropic of Cancer. Similarly the three permanent cyclones whose centers are near the antarctic circle descend as anticyclones near the Tropic of Capricorn. These 6 permanent anticyclone centers lie somewhat to the east of their corresponding cyclonic centers.

In Clayton's "World Weather," p. 40, on a chart of permanent "highs" and "lows" will be found many of the 24 centers above mentioned, and on his p. 19 their effect on ocean currents may be discerned.

It will be noted that this electromagnetic theory of air-whirls and the resulting circulation of the atmosphere differs radically from any theory hitherto advanced. It explains not only the migratory cyclones but the permanent air currents, and it does this without appeal to correction or to differences in centrifugal force on the earth.

The permanent cyclonic whirls increase their intensity and expand in diameter when sunspots increase in number. The ascending cyclonic whirl, being then more powerful, rises to a greater height and descends as an anticyclone at a greater distance from the original cyclonic center, and is also greater in diameter.

Many rainfall paradoxes are readily explained by this theory. For example, the summer monsoons of India bring much rain when sunspots are few, whereas little rain, frequently accompanied by famines, occurs during sunspot maxima.

An anticyclonic whirl that comes from the cyclonic center in the Philippine Islands exists to the west of the latter. In summer it ordinarily causes strong southwesterly monsoons in India, but when sunspots are very numerous its center moves so far westward that these monsoons become very weak. In winter its center moves so far eastward that the northeasterly winds from an anticyclone in Asia predominate. Hitherto this seasonal change in direction of the Indian monsoons has been attributed to convection currents caused by the differences in temperature of the Indian ocean and the land. Similar incorrect explanations have been given of other monsoon winds; for example, those in the United States. Two anticyclonic whirls control these, one centering in the Pacific and one in the Atlantic. The latter is the anticyclone whose cyclonic origin is the whirl that centers near Timbuctoo, Africa. The former has its cyclonic center near the Bering Straits.

The 24 permanent cyclones and anticyclones explain the westward flow of the trade winds within the tropics and the eastward flow of the winds in temperate zones. Also the equatorial calms and those of Cancer and Capricorn are explained thereby.

It should be noted that the permanent cyclonic whirls are whirl-belts, and that relative quiescence exists inside these belts.

In addition to the 24 permanent whirl centers above mentioned there are two others, one at or very near each pole. The one centered at the south pole is clearly cyclonic, the barometer being abnormally low in Antarctic regions. The one centered at the north pole is less clearly cyclonic, and this may be due to a stream of descending air that comes from the great Antarctic cyclone.

One of the by-products of this electromagnetic theory of air movement is that it furnishes an admirable explanation of an enigma that has long puzzled geologists, namely the existence of vast ice caps in low latitudes at times when mild weather existed near the arctic circle. The electromagnetic whirl-belt theory explains such phenomena thus: A very great outburst of sunspots would so concentrate free electrons on the earth as to result in greater intensity of all the permanent whirl-belts. Their great expansion would move certain of these belts into low latitudes; while within those belts there would be relative calm. We see just that condition today inside the whirl-belt whose center is near Timbuctoo, Africa; for there the calm is so extensive that winds do not sweep inward either from the Atlantic or the Mediterranean. It should be noted that this African whirl-belt is the most powerful of all, judged not merely by its present diameter but by its diameter when it raised the mountains that flank the Pacific slope of North America. In the latter case, it was a molten whirl-belt of cyclonic nature that produced this vast crustal uplift, as outlined in the article above mentioned.

For a century meteorologists have complacently dismissed from serious consideration all suggestions that electrodynamics is much of a factor in their realm. Facts, however, point more and more strongly toward electromagnetism as being the greatest of weather factors. This will become increasingly evident in a forthcoming series of editorial articles in this magazine.

Some Remarks on Logic

Two of the oldest—perhaps the two oldest—sciences are mathematics and logic. In some respects they are closely related. In fact all of syllogistic logic can be expressed in the form of equations that serve as premises and are combined to produce the conclusion of inference. However, there is much more to logic than the syllogism, much more than a science of the use of words as a tool of thought. Yet even if there were no more than its verbology, logic would be well worth studying as such.

A part of logic is learned as a by-product of other studies. The same is true of mathematics, yet it is seldom urged that all of mathematics should be learned thus. It is rather surprising, therefore, that there is such a general belief that logic need not be studied as a science by itself. Perhaps the main reason for the prevalence of such a belief is to be found in the character of the text books on logic. Among the best of these is Bain's "Logic," a 700-page book, published by the American Book Co. Written 60 years ago by Alexander Bain, professor of logic in the University of Aberdeen, it is as good as any later treatise written for the beginner. Although all other sciences have marched many a league in the past 60 years, logic has virtually stood still. This very fact points toward some defect in the science of thinking, and perhaps it is the very defect that has led to its decadence.

Herbert Spencer rightly contended that logic should teach certain broad principles relating to matter, for reasoning relates mainly to matter. But practically all logicians have erroneously followed Hamilton's dictum that logic is concerned only with certain laws of thought and their application. Moreover, if there are any laws of thought relating to research and invention, which Hamilton doubts, the logicians are almost unanimous in declaring them not to lie within the province of logic. So, logic, as thought, simmers down to a sort of glorified grammar, which, however useful, is deadly dull. Even as to its utility, doubts may arise; and many a philosopher has vigorously expressed such doubts. Bacon ridiculed the barrenness of Aristotelian logic, and he was not the first to do so, nor by any means the last.

Niell, following Bacon, undertook to reduce inductive (or research) thinking to rules; but did little more than rephrase certain rules that Herschel had printed in his "Discourse on the Study of Natural Philosophy." Neither Bacon nor Niell ever applied the research rules that they laid down, so they failed to see how barren most of them are unless guided by certain principles of which they were ignorant, but of which the real discoverers, like Galileo and Newton, were aware.

Now comes a very curious fact, namely that the greatest of discoverers have rarely laid down a single research rule or principle that is not either self-evident or so vague as to be useless. This fact has often been commented upon. In his "Philosophy of the Human Mind" (an admirable book, written more than a century ago) Dugald Stewart said: "But the language of this great man (Newton), when he happens to touch upon logical questions, must not always be too literally interpreted. It must be qualified and limited, so as to accord with the exemplifications which he himself has given of his general rules." Stewart then refers specifically to Newton's erroneous research rule: "I form no hypotheses * * * Hypotheses have no place in experimental philosophy." Newton's every discovery was based upon some analogy, which inevitably led to an hypothesis, even to that grand hypothesis that the "occult force" gravitation extends beyond the earth to every particle in the universe.

Similarly the research rules given by that other genius, Descartes, are almost all either erroneous or self-evident. When two such men make so poor a fist in writing about their methods of research, there seems to be some truth in the common belief that scientific discovery is an art that can not be taught. However, let no one be hasty in coming to such a conclusion. Very often the men who are busiest in some performance, whether manual or mental, are least capable of instructing others.

Dugald Stewart has to his credit a more comprehensive understanding of the most important principle of research than we have found in the writings of any contemporary or predecessor. He points out that scientific hypotheses are usually based on analogies, and that without hypotheses, the research scientist usually makes little progress. Thus he takes issue with Bacon and with Newton, refuting the latter by pointing to numerous hypotheses that guided his experiments. Stewart barely falls short of insisting that all reasoned-out discoveries have been based on hypotheses that were in turn based on analogies. This generalization, we believe, is true, and failure to perceive its truth has immeasurably retarded the progress of science. Whewell, throughout his monumental "History of the Inductive Sciences" and his later works, also just missed this generalization; and missing it, he formulated a very vague and barren hypothesis respecting the nature of research. Neill, in his "Logic," missed it completely; but a contemporary of Niell, and a more original logician, Stanley Jevons, came very close to a full recognition of the use of analogy in forming hypotheses. In his "Principles of Science," p. 283, he says: "Generalization passes insensibly into reasoning by analogy, and the difference is but one of degree. We are said to generalize when we view many objects as agreeing in a few properties, so that the resemblance is extensive rather than deep. When we have two or only a few objects of thought, but are able to discover many points of resemblance, we argue by analogy that the correspondence will be even deeper than appears." Notice that Jevons says "many points," instead of saying "one point" of resemblance. He just misses seeing that any two phenomena that resemble one another in one respect invariably have other points of resemblance, hidden, it may be but discoverable if we will but follow up the clue furnished by the one point of resemblance.

Jevons (p. 286) says: "There can be no doubt that discovery is most frequently accomplished by following up hints received from analogy, as Jeremy Bentham remarked." Again Jevons fails to see the generality of this rule, or he would have said "always" instead of "most frequently." He is speaking of scientific discovery, and not of accidental discovery; but even accidental discoveries in the realm of science are rarely made by men who have not already formulated some hypothesis, whose truth the "accident" suddenly makes more probable or perhaps certain.

W. P. Gillette

Book Reviews

"Governmental Purchasing," by Russell Forbes, Secretary, National Municipal League; Sec., Governmental Research Association, etc. First edition, 370 pages, 6 in. by 9¼ in., cloth cover, hard binding. Harper & Brothers, New York, publishers. Price, $5.00.

This volume represents a five year study of the functioning of purchasing systems in the federal, state, county and municipal governments of the United States and Canada. No attempt has been made to recommend a "model" purchasing system or to devise "model" forms for its administration because the widely varying legal requirements and local conditions demanded peculiar modifications and precise adjustments in the individual government. Instead, the author has attempted to present a synthesis of the best existing practice, illustrated by representative forms in actual use, of each of the various steps of the purchasing system in which the purchasing office plays a role, from the receipt of a requisition or an estimate of requirements from the using agency, to the approval of the claim for payment. As a further assistance to the practical application of centralized purchasing the author has compiled a representative set of laws, examination questions for the selection of a purchasing staff, salary standards, and other data which are presented in the appendices.

"Stresses Statically Determined," by John Clayton Track, Professor of Civil Engineering, Sheffield Scientific School of Yale University, M. Am. Soc. C. E. First edition, 462 pages, 10¾ in. by 7¾ in., cloth binding. John Wiley & Sons, Inc., New York, publishers. Price, $6.00.

This book was designed to give a thorough working knowledge of the theory of stresses in statically determined framed structures. Considerable attention has been given to explanations of fundamental conceptions, principles and methods, thus permitting the student to master them easily and quickly by himself.

One important statement made in the text follows:

"In any general method of attack, whether it be a problem in stresses or a problem in any other type of engineering work, there are three main steps, namely: (1) To determine what is known, (2) to determine what is unknown or required, and (3) to solve the problem by working from the known to the unknown by some correct and efficient method." The author states that in the subject of stresses there are only eight different types of problems which commonly arise: two in concurrent forces, two in parallel forces, and four in non-concurrent forces. He states, further, that any given problem will fall usually under one of these eight cases according to the number and nature of the unknown elements. Hence, the unknown elements well determine the case.

The book is mechanically arranged for the advantageous use of the material in that diagrams which are being discussed in the descriptive matter is usually before the reader at all times without turning pages. All material is excellently arranged. Illustrative problems clearly demonstrate the point under discussion.

"Field Engineering," by William H. Searles, C. E., Late Mem. Am. Soc. C. E. and Howard C. Ives, C. E., Civil and Consulting Engineer. Twentieth edition, 350 pages in text and 386 pages in table sections, 4⅛ in. by 6¾ in., gold edged, flexible binding. John Wiley & Sons, Inc., New York, publishers. Price $4.00.

A chapter on highway curves has been added to the regular handbook in producing this addition. The treatment is not exhaustive and should have been accorded greater length and more discussion to make it the new section of the equal standard with the remainder of the book. No mention has been made of superelevation or curve widening, both of which should receive discussion in the text.

A point of weakness in the book is the lack of an index. There is a table of contents in the front but to be real usable and act as a handbook this volume should contain a detailed index.

"Structural Problems," by C. R. Young, B. A. Sc., C. E., Mem. Eng. Inst. of Canada, Mem. Am. Soc. C. E., Prof. Structural Eng'g. Univ. of Toronto. First edition, 230 pages, 6 in. by 9 in., cloth binding. John Wiley & Sons, Inc., New York, publishers. Price, $3.50.

This book is written with the point in mind that many students and designers prefer to check their understanding of an unfamiliar theory closely following through an illustrated example. The problems presented do not in any sense constitute a treatise or a complete systematic development of the subject, but merely indicate the method of applying elementary structural theory to the design of characteristic structures, members and details.

The reader is assumed to have a sound basic knowledge of statics and mechanics of materials. Consequently the computation of stresses necessary in the design of the structures has, wherever practicable, been dealt with briefly.

Most of the formulae have not been developed. They are stated only and references have been given in places, to standard texts dealing with structural mechanics and the theory of structures. The book is in its nature supplemental to text books on the theory of stresses and structures.

The author states that the following features are new in printed book form:

1. Determination of the net section of riveted tension members.

2. Determination of the thickness of base plates for riveted steel column bases.

3. Computation of the anchorage of columns subjected to overturning.

4. Determination of rivet tension in column brackets and beam connections.

5. Design of a cantilever shelter truss.

6. Design of a stationary jib crane.

Complete design of a timber bent for a flume trestle.

"Chemistry in Medicine," edited by Julius Stieglitz, Professor of Chemistry, University of Chicago, with Board of Advisory Editors. First edition, 757 pages, 5½x7½ in., flexible leatherette binding. The Chemical Foundation Co., Inc., New York, publishers. Price upon application to publishers.

This book presents to the public as well as to the practitioners of medicine the great possibilities for advance in medical science through further intensive cooperation between chemistry and medicine. Chemistry is the fundamental science of the transformation of matter, and our life, from our inception to our return to dust, in every breath we draw and in every moment we live, is indissolubly connected with most complex transformations of matter.

Each different subject in the text has been written by a specialist on that subject. Physician, physiologist, pharmacologist, bacteriologist, pathologist and chemist have united efforts in the production of this excellent volume. The following chapter headings give an indication of the type of contents:

I. The Significance of Chemistry and of Its Methods of Attack on Fundamental Problems.

II. Heredity and Development.

III. The Human Body As a Machine.

IV. The Story of the Discovery of Vitamins.

V. The Conquest of Dietary Diseases.

VI. Chemical Regulators of the Body.

VII. The Policing of Civic Life in the Laboratory.

VIII. The Alleviation of Suffering.

IX. The War on Invading Germs.

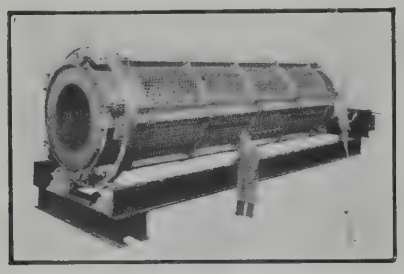
X. A Hope of Mankind—Chemo-Therapy.

"International Airports," by Stedman S. Hanks, Lt. Col., Air Corps Reserve. First edition, 195 pages, 5¾ by 8½ in., hard cover cloth binding. The Ronald Press Company, New York, publishers. Price, $5.00.

This is a discussion of airport construction and facilities told in a narrative style. Various airports of Europe and America are described. Methods of handling passengers and freight are discussed. Lighting, communication, management and insurance are items treated in the book. The many illustrations show airport arrangements much better than word descriptions. The author traveled to all of the principal airports of Europe by airplane. His discussion is the result of first hand impressions.

All Roller Bearing Screens

In the new plant of the Van Camp Sand & Gravel Co. at Lebanon, O., every piece of machinery will be equipped with antifriction bearings. One of the screens, a 72-in. Telsmith-Hercules, built by the Smith Engineering Works of Milwaukee, Wisconsin, is



New Telsmith Roller Bearing Equipped Gravel Screen

equipped throughout with Dodge-Timken roller bearings and has a capacity of 300 cu. yd. of sand and gravel an hour. It has an extra heavy frame, all gears are enclosed and special protection is provided for the bearings.

The Van Camp plant, which is rapidly nearing completion, will have a daily capacity of 3,000 cu. yd. of washed sand and gravel. The 72-in. screen will be used as a scalper to precede two 60-in. Telsmith-Hercules washing screens, one of which will be used for classifying gravel and the other for the production of crushed stone. Arrangements are provided for diverting the flow of material from one screen to the other as may be necessary. These two 60-in. screens are also being built by the Smith Engineering Works and equipped with Dodge-Timken roller bearings.

Concrete Tree Trunk Park Incinerator

To eliminate the objectionable feature of daily collecting rubbish from refuse cans and to provide a receptacle rather more attractive than the usual refuse container, there has been developed a reinforced-concrete incinerator, designed to resemble the trunk of a tree. They are in use in a number of cities, about 350 of these incinerators having been placed in Central and Riverside parks in New York City. Each receptacle is provided with a grate at the bottom, so that the park attendant merely burns the contents each evening. There are two holes directly under the grate to permit draft and to allow removal of ashes. The interior of the incinerator is lined with fireclay. These incinerators have been developed by the Municipal Products Company, Grand Central Terminal Building, New York City.

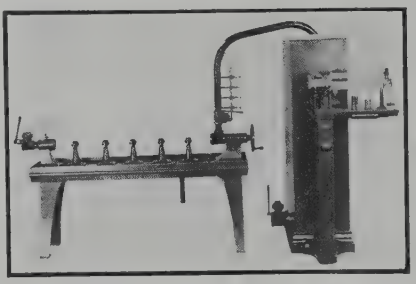
Tree Trunk Type of Incinerator of Reinforced Concrete

Clark Meter Testing Machine Improved

A slight change has been made in the Clark Meter Testing Machine for testing the accuracy of water meters.

The electric alarm bell which has been used to signal the closing of the test on water meters has been replaced by an electric buzzer. In several cases where the Clark Meter Testing Machine was located near the telephone, it was difficult to distinguish between the bells.

The electric buzzer on the Clark



Clark Meter Testing Machine

Meter Testing Machine is quite an aid in the testing of meters on small flows.

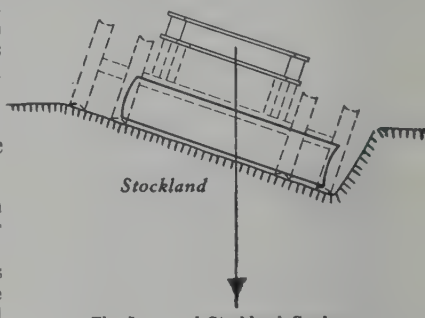
In testing on a small flow or on quantity tests for accuracy, the operator may leave the machine and occupy himself with other duties. The electric buzzer calls the operator a few seconds before the close of the test.

Stockland Improves Grader

One of the design features of the Stockland road grader is its low center of gravity with plenty of blade clearance. This, the manufacturer states, is strictly a Stockland feature which has been carefully worked out by the engineers who are constantly working to give the users of road graders efficient equipment.

Because of this low design, it might appear that there would not be enough blade clearance. It is claimed, however, that all Stockland graders have a blade clearance equal to graders built higher from the ground, and yet have all the advantages of a low center of gravity design. The circle assembly can be raised the full height of the frame if necessary.

The center of gravity comes directly through and very close to the center of the cutting blade when on a 2 to 1 slope. As the design of a grader is made higher, the perpendicular line drawn from the center of the grader frame down through the blade will come correspondingly closer to the outside edge of the blade instead of the center when on a slope.



The Improved Stockland Grader

Some of the other design features claimed for the Stockland grader are the cut-lift-roll curved blade, proper location of blade, extra long wheelbase, three-point suspension, fewer working parts and heavy frame construction. All of these interesting features are dwelt upon in the new Stockland S-100 Grader Book.

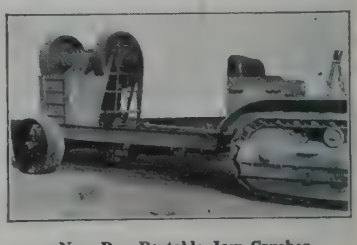
Foote Bros. Gear & Machine Company, 111 N. Canal St., Chicago, Ill., who have recently taken over the Stockland Road Machinery Company, Minneapolis, Minn., will be pleased to send you one of these Grader Books upon request, without obligation.

Tractor Drawn Crusher Announced

The new Day Jaw Crusher, manufactured by the Day Pulverizer Co., of Knoxville, Tenn., is driven direct from a Caterpillar power take-off.

It can be attached in two minutes as the drive assembly has two universal joints and there is no delay for alignment. It is fed from the side and may be moved forward as it crushes.

Adjustments are easily made for any size material while the machine is in operation. With its short turning radius, simplicity and ruggedness of construction, it provides to counties and various others a most economical machine as it provides crushed materials right on the job.



New Day Portable Jaw Crusher

Water Works and Sewerage

Vol. LXXVI SEPTEMBER, 1929 No. 9

New Service Building of the Portland Water District

New England Water Works Association Holds Annual Meeting at Portland

Program of 48th Annual Convention of Association

THE 48th annual convention of the New England Water Works Association will be held at Hotel Eastland, Portland, Me., September 17, 18, 19 and 20.

The convention office of the secretary will be located in the lobby on the first floor, Hotel Eastland, and will be opened for registration at 3 p. m., Monday, September 16. The registration office will not be open evenings after 6 p. m.

Technical Meetings and Exhibits.—The exhibits will be located in the Sunrise room of the hotel. Technical sessions will be held in the ballroom and other rooms as posted. Victor E. Arnold, of the Pittsburgh Equitable Meter Co., New York, is chairman of the committee on exhibits.

Transportation.—Portland is reached by three railroads, the Maine Central, the Boston & Maine and the Grand Trunk. No special arrangements have been made with any of the railroads for transportation, as many of the members of the association wish to go to Portland by automobile.

Electric car lines serve the city and its suburbs, and give first-class service to the beaches and near-by resorts. Portland's airport, in the town of Scarboro, about six miles from the center of Portland, is one of the largest and best equipped in the east.

Program.—The program, as arranged by the program committee, of which Robert Spurr Weston is chairman, follows:

TUESDAY, SEPTEMBER 17

Morning Session, 10:00 a. m.

Address of Welcome by
His Excellency William Tudor Gardiner, Governor of Maine.
Lester F. Wallace, Chairman Board of City Councilmen, City of Portland.
William L. Blake, President Board of Trustees, Portland Water District.

Secretary's Report
Treasurer's Report
Editor's Report
Award of Dexter Brackett Medal
Committee:
Gordon M. Fair, Chairman
Frank A. McInnes
G. Earl Lourie

Closing of Polls
Appointment of Tellers

REPORTS OF COMMITTEES ON

Tests of the Bureau of Standards, Harry W. Clark, Director and Chief Chemist, Water and Sewage Laboratories, Mass. Department of Public Health, Chairman.

The Collection and Correlation of Information Concerning the Corrosion of Iron and Steel Pipes and Standpipes, Caleb M. Saville, Manager and Chief Engineer, Board of Water Commissioners, Hartford, Conn., Chairman.

Standardization of Pipe Flanges and Fittings, Wm. R. Conard, Conard & Buzby, Burlington, N. J., Chairman.

Specifications for Cast-Iron Pipe and Special Castings, Chas. W. Mowry, Assistant Manager, Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass., Chairman.

Of the Sponsors for the Section Committee on Standardization of Cast-Iron and Special Castings, Wm. R. Conard, Conard and Buzby, Burlington, N. J., Chairman.

Standard Specifications, C. W. Mowry, Assistant Manager, Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass., Chairman.

Standardizing the Steps of the Meter Schedule, Arthur E. Blackmer, Superintendent of Water Works, Plymouth, Mass., Chairman.

Wrought-Iron and Wrought-Steel Pipe and Tubing, Chas. W. Mowry, Assistant Manager, Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass., Chairman.

What Arrangements Can Be Made Toward Carrying Out Some of the Experiments Which Dr. Barnes Would Like to Make in Connection with Using Thermit Heat Units on Frozen Hydrants, Etc., P. R. Sanders, Superintendent of Water Works, Concord, N. H., Chairman.

Yields of Catchment Areas, X. H. Goodnough, Director and Chief Engineer, Massachusetts Department of Public Health, Chairman.

Convention Committee, 1929, James W. Graham, Treasurer and General Manager, Portland Water District, Portland, Maine, Chairman.

Afternoon Session, 3:30 p. m.

A Description of the System of the Portland Water District by James W. Graham, Treasurer and General Manager, Portland Water District.

History of the Organization of the Portland Water District by David E. Moulton, Clerk and Attorney of Portland Water District.

Beauty in Water Works Structures by John Calvin Stevens, Architect.

Evening, 7:30 p. m.

Color Reduction in Storage Reservoirs by Caleb Mills Saville, Manager and Chief Engineer, Board of Water Commissioners, Hartford, Conn.

Hotel Eastland, Portland, Me., Headquarters of New England Water Works Association Convention

A Study of Color Removal by H. W. Clark, Director and Chief Chemist, Water and Sewage Laboratories, Massachusetts Department of Public Health.

WEDNESDAY, SEPTEMBER 18

Morning Session, 9:00 a. m.

A Year's Experience with Automatic Chlorination at Concord, N. H., by Percy Sanders, Superintendent of Water Works, Concord, N. H.

Typhoid Fever in Eastern United States by Chester F. Drake, Superintendent of Filtration, Pittsburgh, Pa.

Evening, 7:30 p. m.

Superintendents' Meeting

Report of Legislative Committee.—S. S. Anthony and George A. King.

Report of Committee on Painting Standpipes.—A. O. Doane, Chairman.

Followed by a General Discussion.

Test of Large Meters in the Field by R. F. Ferguson, Assistant Superintendent, Hersey Mfg. Co., Boston, Mass.

Experience with Diesel Engines in Water Works Plants by A. D. Couch, Mechanical Engineer, Community Water Service Co., New York City.

THURSDAY, SEPTEMBER 19

Morning Session, 9:00 a. m.

Method of Testing Cast-Iron Pipe by Wm. R. Conard, Conard & Buzby, Burlington, N. J.

Paper by E. E. Lochridge, Chief Engineer, Springfield Water Works, Springfield, Mass.

Afternoon Session, 2:30 p. m.

The Reconstruction of the Pumping Station of the Western New York Water Company at Buffalo in Connection with the Construction of a 20,000,000-Gallon Filter Plant, by H. W. Huy, General Manager, Western New York Water Co.

Making of Water Flow and Pressure Studies by the Water Works Engineer by Herbert E. Smith, of the Simplex Valve and Meter Co., Philadelphia, Pa.

FRIDAY, SEPTEMBER 20

Morning Session, 9:00 a. m.

Watching the Weather in Safeguarding Public Water Supplies by Arthur E. Gorman, Sanitary Engineer, Wallace & Tiernan Co., Arlington, N. J.

Changes in Power for Pumping at Newport, R. I., by Harold Watson, Superintendent of Water Works, Newport, R. I.

Report of Tellers—Election of Officers. President's Address.

Entertainment.—Burt B. Hodgman, chairman of the entertainment committee, has announced the following program:

TUESDAY, SEPTEMBER 17

1:00 p. m.—Maine clam chowder luncheon at new shops of Portland Water District followed by inspection of shops and standpipe painting inspection. Ladies are invited. (Courtesy of Portland Water District.)

8:00 p. m.—Informal reception for ladies at Hotel Eastland.

8:15 p. m.—Theatre party for ladies. (Courtesy of Geo. F. West & Son.)

WEDNESDAY, SEPTEMBER 18

11:30 a. m.—Clam bake and sail, Casco Bay. (Courtesy of Water Works Manufacturers' Association, Inc.)

8:00 p. m.—Ladies' Reception and bridge at Hotel Eastland. (Courtesy of Water Works Manufacturers' Association, Inc.)

THURSDAY, SEPTEMBER 19

10:00 a. m.—Sight-seeing trip for the ladies. Buses leave Hotel Eastland 10:30 a. m. (Courtesy Portland Chamber of Commerce.) Followed by coffee at Portland Chamber of Commerce.

7:30 p. m.—Dinner-dance and entertainment at Hotel Eastland. (Courtesy of Water Works Manufacturers' Association, Inc.)

Golf Tournament.—(Time to be announced.)

FRIDAY, SEPTEMBER 20

10:00 a. m.—Shopping tour through Portland business district. (Courtesy of Portland Chamber of Commerce.)

Operating Experiences With New Water Softening Plant at Marion, Ohio

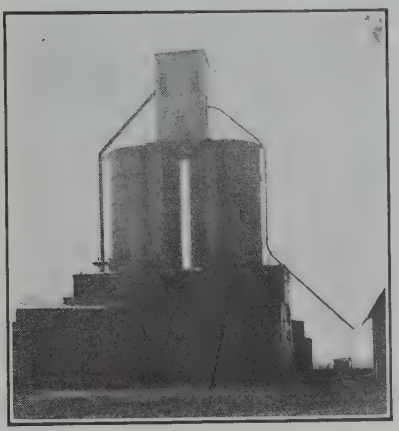
Double Carbonation Produces Effluent of Low Alkalinity

By MARTIN E. FLENTJE and CHARLES WHYSALL
Superintendent of Purification, Community Water Service Co.;
Chemist in Charge, Marion Water Co.

THE water softening plant of the Marion, Ohio, Water Co., a subsidiary of Community Water Service Co. of New York City, is unusual from several standpoints. Probably first of all is the extreme hardness of the water being treated; secondly, the use of all steel construction above ground; and finally in the application of double carbonation to produce an effluent of low alkalinity.

The Supply.—Water is at present obtained from 14 wells in limestone, varying in depth from 140 to 225 ft. Motor driven pumps deliver the water to collecting troughs leading to a concrete basin. During passage through these troughs and while spraying over small aerators, the raw water loses some CO_2 gas, and the dissolved iron is oxidized. Oxidization and precipitation of the iron results in an apparent turbidity of 150 p.p.m. in the collecting basin. Typical partial analyses of well waters are given in Table I.

The Softening Plant.—The water is pumped to the two 30 ft. in diameter mixing tanks, receiving on its way the milk of lime prepared in the headhouse. Browning-Montgomery chemical dry feeders are used. A 100 g.p.m. capacity



Chemical House and Chemical Storage Tanks; Airneyar Filter House

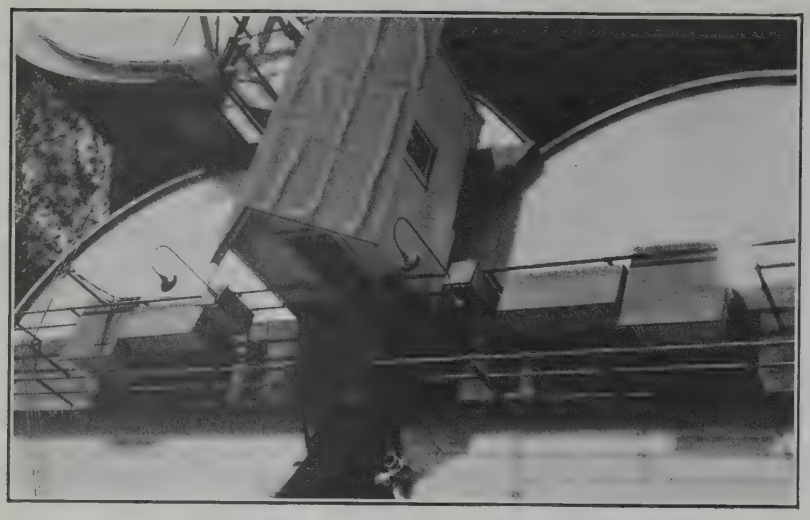
ejector adds the lime water to the water to be treated, while the former soda ash injector has been replaced by a small centrifugal pump.

Soda ash is applied at the top of the second mixing chamber. Marble Cliff (Ohio) Pebble Lime and Solvay Soda Ash are used. The mixing basins are 24 ft. in height, as are all other basins. A single paddle is located near the bottom, and is driven by a variable speed motor. Water enters tangentially at the bottom, spirals upward, overflows into the bottom of the second basin and repeats the process. The retention period in the mixing basins is 4-5 hours at the present rate of flow, with a minimum retention of 1 hour at plant capacity.

From mixing chambers, the water flows to the 120 ft. diameter Dorr Clarifier, flowing into the 30 ft. stilling chamber in the center 12 ft. downward, and then outward, finally overflowing into the launders at the periphery of the tanks. The sludge is removed from this clarifier by means of Dorr sludge pumps and contains between 65-75 per cent moisture.

The second settling tank is not equipped with clarifier mechanism, although the stilling well, etc., are arranged for its installation if found desirable. In this stilling well carbonation of the free lime present to normal carbonates is carried on, and some alum added. A retention period at plant capacity of 19 hours has been provided for in each basin; at present rate of

View of Water Softening Plant at Marion, O., Showing, Left to Right, Mixing Tanks, Dorr Clarifier, Final CO_2 Chamber and Settling Tanks



Mixing Tank and Sludge Pump House

flow 48 hours is the period. An effluent having a turbidity of 2 p.p.m. or less is produced in the Dorr Clarifier, with a final plant effluent turbidity of less than 1 p.p.m.

Final carbonation is carried out in a carbonating basin, 26 ft. in diameter with a retention period at present of 1¾ hours.

Chemicals are unloaded by vacuum, an Airveyor system being used.

Operation.—A number of laboratory tests indicated that with a lime dosage of 25 grains per gallon, or a theoretical excess of 6 grains; a minimum of soda ash required with a maximum hardness removed would results. Such a lime dosage insured complete precipitation of all the magnesium present, and eliminated some of the troublesome complex reaction products, commonly resulting in high alkalinities. This lime dose resulted in a causticity or free lime content of 30 p.p.m.—and this figure has been used as a guide in the treatment control. The soda ash dose is varied with the raw water hardness and to give any desired plant effluent. Typical analyses of various steps in the softening process are given in Table II.

Average operating results for various months are given in Table III.

Some operating difficulty has been experienced in preventing the clogging of the chemical feed lines. Sufficient diluting water has, however, solved this problem so well that the present lime line has not been cleaned for 8 months, and the cleaning time for the soda ash line has been extended from weekly periods to periods of 30 days.

Discussion of the proper place to carbonate to the normal carbonate stage led to an experimental installation of a carbonating grid at the influent to the Dorr Clarifier. This location was considered as practically identical with carbonation directly in the mixing basin effluent. The results of this experiment were quite unsatisfactory, as low alkalinities could not be obtained and very poor settling resulted. Higher causticities were apparently carried in the mixing chamber during the time of making this test and insufficient CO_2 gas added. Plotting the daily results, however, indicates that the poor results must have been due to some obstruction to the reaction between the CO_2 and the free lime—as at various times very high causticities have not resulted in high effluent alkalinities when the first carbonation was carried on in partially clarified water. Carbonating at this point also resulted in the formation of very small floc particles which would not settle readily. The turbidity of the plant effluent was increased from 1 p.p.m. or less to 10 or 15 p.p.m.

An inspection of Table III shows that a decrease in the pounds of soda ash per m.g. had occurred. This is probably due to increased time of retention in the mixing basins. A change in the rate of flow through the basins is apparently directly reflected in the soda ash required.

This decrease in soda ash required represents a saving of approximately $4.00 per million gallons, or an additional removal of approximately 30 p.p.m. hardness (non-carbonate) with the same chemical dose formely used.

Double carbonation has resulted in alkalinities averaging 30-35 p.p.m., whereas in laboratory tests without double carbonation, alaklinities below 65 p.p.m. could not be produced. Double carbonation has then resulted in a removal of 30 p.p.m. hardness at a cost of practically nothing, a constant

Table I—Typical Well Water Analyses Marion, Ohio

Well No.	No. 2	No. 4	No. 15	No. 17	No. 25	No. 20
Alkalinity (as $CaCo_3$)	312	318	306	275	306	240
Non-Carbonate Hardness	736	529	392	507	294	452
Total Hardness	1048	847	698	782	600	692
Magnesium	56	47	45	49	38	46
Free CO_2	72	67	57	50	35	45

Table II—Typical Analyses at Various Steps in Softening Process—Marion, Ohio

	Raw	Mixed	Clarified	Settled after 1st Carbonation	Carbonated
Total Alkalinity p.p.m.	303	61	69	35	33
Phenol Alkalinity p.p.m.	0	50	59	19	6
Causticity p.p.m.	0	39	49	3	0
Non-Carbonate Hardness p.p.m.	438	168	109	111	106
Total Hardness p p.m.	741	229	178	146	139

Clarifier and Settling Tanks, View Taken from Top of Chemical Storage Tanks

amount of coke being used, regardless of whether single or double carbonation is carried on. If, however, it is assumed that ½ of the total coke used is necessary to produce this result, costs would be as in Table IV.

Sludge disposal is rapidly becoming a serious problem and considerable study is being given this problem. No practical solution, however, has as yet been found.

The temperature changes taking place through the plant may be of interest. The well water has a constant year around temperature of 54 deg. F. During the winter the water in the basins gets as low as 37 deg.

The Marion Water Co. softening plant was designed by C. P. Hoover of Columbus and constructed under the direction of Geo. Whysall, manager of the Marion Water Co., under immediate supervision of Chas. Whysall, now chemist in charge.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

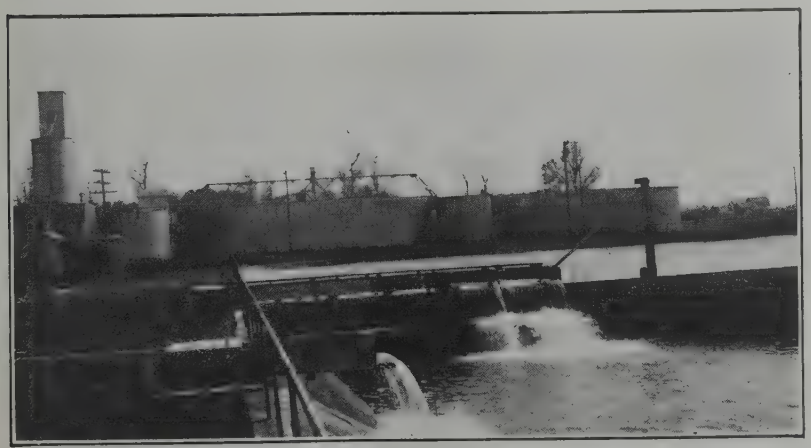
Clarifier, Settling and Carbonation Tanks

Table III—Average Operating Results—Marion, Ohio

	Gallons treated m.g.	Lime lbs. per m.g.	Soda Ash lbs. per m.g.	Alum lbs. per m.g.	Coke lbs. per m.g.	Lime data lbs. per m.g. per p.p.m. alkalinity reduced	lbs. per m.g. per p.p.m total alkalinity	Soda Ash lbs. per m.g. per p.p.m. non-carbonate hardness removed
Aug.	42,234	3,775	2,875	39	293	13.8	12.3	11.8
Sept.	30,663	3,040	3,040	34	391	15.4	13.9	13.8
Oct.	28,000	2,970	2,970	37	443	16.0	14.3	11.9
Nov.	30,247	3,061	3,061	56	204	15.7	14.1	10.1
Dec.	30,601	3,057	3,057	49	101	14.6	12.7	10.5
Jan.	31,142	3,080	3,080	47	99	14.9	13.2	10.6
Feb.	32,057	3,090	3,090	45	87	14.3	12.6	10.4
Mar.	32,785	3,115	3,115	55	100	14.2	12.5	9.9

Table IV—Cost of Removing Hardness by Double Carbonation

Month	Total coke lbs. per m.g.	Assumed cost per m.g. of carbonation	Cost per p.p.m. hardness removed	Total ave. cost for removing 1 p.p.m. hardness (with lime and soda ash)
Aug.	293	$0.51	0.014	
Sept.	391	0.68	0.019	
Oct.	443	0.77	0.021	
Nov.	204	0.70	0.021	
Dec.	101	0.35	0.010	
Jan.	99	0.34	0.010	
Feb.	87	0.31	0.009	
Mar.	100	0.35	0.010	
Ave.				$0.097



View Shows Corner of Raw Water Basin in Foreground; Also Two of the Aerating Troughs

Survey of Fire Hydrants in New Jersey

The recent survey of fire hydrants in North Hudson and Eastern Bergen counties covering 48 cities and towns supplied by the Hackensack Water Co. revealed a wide variation in the average spacing of these outlets of the water distribution system, according to a report made public by the president of the company, Nicholas S. Hill, Jr.

"In North Hudson County," says the report, "the extremes are West New York, 438 ft., compared with Secaucus, 781 ft., between hydrants.

"In Bergen County, the difference is more striking when one compares Edgewater, 352 ft., with Washington Township, 1,830 ft. It is, however, only fair to point out that Edgewater has large industries concentrated along a narrow belt of water front, whereas Washington Township is but recently opened to what promises to be a successful development.

"Taking all towns it is found that four have hydrants averaging less than 500 ft. apart, six have hydrants averaging from 501 to 600 ft. apart, six have hydrants averaging from 601 to 700 ft. apart, twelve have hydrants averaging from 701 to 800 ft. apart, five have hydrants averaging from 801 to 900 ft. apart, four have hydrants averaging from 901 to 1,000 ft. apart and ten have hydrants averaging over 1,000 ft. apart. The general average of all is 740 ft.

"The distances between hydrants over 1,000 ft. apart are, in the ten towns, 1,023, 1,070, 1,100, 1,150, 1,155 1,157, 1,204, 1,220, 1,392 and 1,830.

"If firemen must stretch two lines of hose, each at least 600 ft. long, to reach a burning dwelling midway between two hydrants 1,150 ft. apart, they are compelled to substitute the limited capacity of 2½-in. crooked hose for the far greater flow of an iron water main at least 6 in. in diameter which passes the dwelling and should properly have a hydrant connected to it at about that point."

Fire chiefs, the water company officials point out, are alive to the menace of such situations, and are on record as requesting municipal officials to order additional outlets attached to the existing water mains.

Symbols for Hydraulics.—The proposed American tentative standard symbols for hydraulics have been adopted by the sectional committee on scientific and engineering symbols and abbreviations and by the five sponsor bodies. The report is now being balloted by the American Standards Association. Copies of the proposed American Tentative Standard are available for review by those interested, and may be obtained on loan from the American Standards Association Information Service, 29 West 39th St., New York City.

Activated Sludge Practice in United States

General Features of Design and Treatment in Twelve Plants

EARLY in 1928 the Board of Estimate and Apportionment of New York City appointed a special committee consisting of C. W. Berry, controller, and Arthur S. Tuttle, chief engineer, to inspect methods of sewage disposal in use in other cities.

In all 16 plants were inspected as follows:

Chicago, Ill.—North Side.
Chicago, Ill.—Calumet.
Chicago, Ill.—West Side.
Chicago, Ill.—Des Plaines River.
Indianapolis, Ind.
Antigo, Wis.
Milwaukee, Wis.
Lodi, Cal.
Pomona, Cal.
Pasadena, Cal.
Long Beach, Cal.
Harbor City, Cal.
Los Angeles, Cal.—Hyperion (North Plant).
Grand Canyon, Ariz.
Houston, Tex.—South Side.
Houston, Tex.—North Side.

The object of the inspection was to secure information as to the applicability of the activated sludge process to a plant on Ward's Island; whether it might be a source of nuisance to the neighborhood; whether it was so far developed as to be dependable in operation; and whether it would prove an economical solution for the disposal of the tributary sewage.

Eleven plants employing the activated sludge process, and a twelfth where it is employed in part, were visited, while the other plants contained special features, such as fine screens and sludge digestion, that bear directly upon the New York City problem.

The salient features of the plants visited are reviewed by Kenneth Allen, sanitary engineer, office of the chief engineer of the Board of Estimate and Apportionment, in a report of the special committee. The notes following are taken from the report.

Coarse Screens.—Coarse screens are generally placed in front of pumps, fine screens, or other devices requiring protection from large floating material that might cause injury. The usual form is the inclined rack of parallel bars, spaced up to 5 in. apart and cleaned by hand, but in large installations some mechanical equipment is desirable.

At the North Side Works, Chicago, at Milwaukee, and at the South Side Plant at Houston cage screens are used in pairs, one being in service while the other is raised by power and cleaned by hand. These screens are adapted to large flows and deep sewers, when the limited amount of manual labor is justified.

At the West Side Works, Chicago, and the Hyperion Plant, Los Angeles, the Dorrco coarse screen is used. This is simple in design and mechanically operated, the curved rack being cleaned by a rake connecting the outer ends of radial bars rotating on a horizontal axis. This is a revival of a type of screen used in Germany and may well be adapted to many situations.

Fine Screens.—Fine screens of the Riensch-Wurl type are in use at the Des Plaines River Works, Chicago; of the Tark or Link-Belt type at Milwaukee; of the Dorrco type at Lodi, Pasadena, Long Beach and Los Angeles; and of the Hurd type at Indianapolis. Those at Chicago, Milwaukee, Lodi, Pasadena and Indianapolis furnish preliminary treatment for the activated sludge process, while at Long Beach and Los Angeles their function is to protect near-by bathing beaches. The Milwaukee, Indianapolis and Los Angeles installations are important as to size and are excellent examples of their kind. In general the trend seems to be in favor of slotted plates rather than wire mesh, and with 1/16 in. x 2 in. slots.

There are so many factors upon which screen performance depends that comparisons are difficult. Tests, unless made in parallel on the same sewage, are liable to be grossly misleading and it is a question whether there is a material difference in efficiency in the above standard types of screen. If a fine screen is considered preparatory to activation the choice of fineness will depend somewhat on whether the sludge is to be made into fertilizer, in which case it may be desirable to permit more solids to pass through, in order to increase the marketable product, but the cost of aeration will probably be greater. If the screen is for the protection of the waterfront the end to be sought is the removal of solids offensive to sight, and for this any one of the above screens operating with a slot 1/16 in. wide will serve the purpose. While, as stated, individual tests vary greatly, average removal of about 10 per cent of the suspended solids may generally be expected, but whether this is 5 per cent or 15 per cent the main object of screening has been accomplished unless further protection by chlorination is necessary, in which case a high removal of solids to reduce the cost of chlorine may be desirable.

The removal and moisture at these plants is shown in Table I.

In choosing a fine screen it would seem that too much stress has been laid in the past on efficiency as shown by short tests. Reliability of performance, durability, first cost and upkeep are believed to be matters of much more importance, and concerning these information is gradually accumulating with longer experience.

The disposal of screenings by burying in small quantities and in rural areas is often the simplest and best method. Where the volume is large, as at Los Angeles and Long Beach, or where the plant is in urban territory, as at Milwaukee, the problem is more difficult and a choice must be made of several possible procedures.**

At Milwaukee experiments in digesting the screenings and then mixing them with the sludge going to the filters are proposed. Whether this will affect the filterability of the sludge unfavorably or not remains to be seen. It will probably dilute to a small extent the nitrogen in the dried sludge but will also increase the volume of the sludge, as occurs when plain settled sludge from preliminary tanks is added to the output of activated sludge.

At Hyperion the Los Angeles screenings are buried in the sand but are exposed to a certain extent by the gulls that are attracted to the spot and some more satisfactory method of disposal is being sought. Experiments reported by D. C. Warfel have indicated that by distillation there may be recovered from one ton of screenings 85 per cent moisture, about 800 cu. ft. of gas containing 400 b. t. u., 100 lbs. fuel oil and 150 lbs. of fertilizer base containing 1½ per cent nitrogen, 3.2 per cent phosphoric acid and 1.0 per cent potash, valued at 1.50 per ton of wet screenings. These experiments are to be extended and the foregoing results must be considered provisional.

Long Beach appears to have solved the problem of disposing of its screen-

*Weighing 135 lb. and containing 20 lb. dry solids in 1925. This represents a removal of 2 p.p.m. out of 164 p.p.m. suspended solids in the raw sewage.

**The screenings from the New York City Canal St. and Dyckman St. plants are collected and disposed of with the much larger volumes of garbage. This seems to be the most satisfactory means of disposal under the circumstances, but where the wet screenings are dumped in large quantities into an incinerator, as attempted at the Jamaica plant, it has been found to interfere with proper combustion.

Table I

	Removal cu. ft. per m.g.	Moisture per cent	Disposal
Chicago—Des Plaines River	4±*	85	Dumped and buried
Milwaukee	7.5	90	Dumped
Lodi	12	87	
Pasadena	30	88	Buried
Long Beach	40	80	Burned
Los Angeles	16.5	87	Buried

ings satisfactorily. This is by incinerating in a home-made furnace with natural gas supplied by the municipality. Under existing conditions this is an economical and satisfactory method of disposal and one that deserves consideration when cruder methods are unsatisfactory.

Sedimentation Tanks. — In settling sewage it should be discharged from the tank, if possible, before it has a chance to become septic. Therefore contact with decomposing sludge or a long period of detention in the tank is generally to be avoided. Consequently, the plain sedimentation tank with mechanism for the prompt removal of the sludge has come into favor.

In the plants visited plain sedimentation tanks with hopper bottoms are found in one-half of the Des Plaines River Works at Chicago and at the South Side Plant at Houston, Imhoff tanks at the Calumet Works (for presettling) and at the West Side Works, Chicago, and at Pomona, and tanks with the mechanical removal of sludge at the North Side Works and the West Side Works (skimming tanks), Chicago, at Antigo, Milwaukee, Lodi, Pomona, Harbor City and Grand Canyon for final settling and at the Chicago North Side Works and the Harbor City plant for pre-settling as well. Tanks of this type are frequently called "clarifiers."

The Link-Belt clarifier consists of scrapers which push the sludge to a sump at one end of a long rectangular flat-bottomed tank. These "flight conveyors" are operated by endless chains on each side passing over sprocket wheels at the end. In their return at a higher level they may also serve to break up the scum or skim off the grease. This device is installed in the skimming tanks of the West Side Works, Chicago, and in the pre-settling tanks at Harbor City.

The Hardinge clarifier resembles the Fidler apparatus found in Germany, in which a spiral scraper rotating slowly in the bottom of the tank collects the sludge to an outlet pipe in the center. This device is to be installed at the North Side Plant at Houston and at Pasadena.

The Dorr clarifier, installed at the other plants employing mechanical removal, is similar to the Hardinge in that the sludge is gradually scraped to a sump or outlet at the center, but there are short scrapers set diagonally on four radial arms in place of a single spiral scraper. By a special mechanism one or more of these arms is automatically extended and withdrawn so as to collect from the corners of a square tank.

Each of the above types of tank has a field of usefulness: the tank with hopper bottoms and the Imhoff tank where their depth is not too costly, the hopper-bottomed and those mechanically cleaned where the sludge can be disposed of while fresh or held to decompose, as in separate digestion tanks, etc. The tanks of the clarifier type appear to be especially adapted to situations where excavation is costly, to final settling in connection with activated sludge or tricking filter plants or where removals of 40 or 50 per cent of the suspended matter is desired within relatively short periods. Sixteen separate digestion plants were installed in the United States in 1927 and 1927.

By digesting sludge the volume is reduced and the product is more readily drained or filtered and is free from objectionable odor. During the process methane gas of good calorific value is given off. By proper control of the acidity and temperature of the sludge the volume of gas may be materially increased. In Germany it has been sold to gas companies, at Birmingham it is utilized for power, and in the United States there are now several plants where gas recovery is an important feature. The largest of these has just been installed at Decatur, Ill., but that at Antigo, though one of the first, is of especial interest on account of its careful design and successful operation in spite of adverse climatic conditions. Gas collection may be used in connection with Imhoff tanks but more perfect control is possible with separate digestion tanks. The gas at Antigo is not utilized except to heat the sludge although a certain excess is available in summer. The gas produced at several plants is as follows (Table II):

Table II

Place	Cu. ft. per cap. daily	Methane per cent	B. t. u. per cu. ft.
Chicago—Calumet	0.4(0.1-1.1)	85	700
Atlanta, Ga.	———	———	700
Birmingham, Eng.	———	67	625-750
Essen-Rellinghausen, Germany	0.3	65-90	785-1010
Decatur, Ill.	.14-.51	70-80	700
Stuttgart, Germany	0.35	75.5	840-955
Antigo, Wis.	0.78	———	656

The amount of gas produced at Antigo is relatively high but in the opinion of the designer, Mr. Jerry Donohue, who has carefully watched its operation, "1 cu. ft. of gas per capita per day is not an unreasonable amount to expect where the design calls for a gas-tight digestor and where no leaks permit the escape of gas about the plant." So far as the above plants are concerned it would be a fair inference that under ordinary conditions at least 300 b. t. u. per capita could be recovered daily which, with coal at 12,000 b. t. u. per lb., would be equivalent to 4½ tons a year for every 1,000 persons. Where the sewage is strong, the cost for fuel is high, and sludge digestion is feasible, the recovery of gas for power, heat or lighting should be considered. The volume recovered will depend on the character of the sludge, being generally greater with strong domestic sludge and increased if mixed with activated sludge maintained at optimum temperatures and pH values and gently mixed by stirring.

Aeration Processes.—Of the plants visited pre-treatment at the Des Plaines River Works, Chicago, at Milwaukee, Indianapolis, Lodi and Pasadena is by fine screening. This includes the three plants where fertilizer is produced as, with the limited percentage of removal of solids desired, fine screens generally take less space and are less costly than tanks. In some situations, however, it is possible that shallow tanks providing a brief detention may be quite as cheap while serving as well for the removal of grease by skimming. At Houston the sewage is merely coarse-screened before aeration.

In the matter of aeration the "Manchester system" of spiral flow is adopted at the North Side Works and in one unit at the Des Plaines River Works, Chicago, at Indianapolis, Pomona and Harbor City, these being in general the newer plants. At Pasadena experiments have shown no advantages in spiral flow, probably due to the narrow width of tank. At Harbor City perforated pipes were adopted in place of diffuser plates for economical reasons in a temporary plant, but with apparently good results. At Pasadena the Norton plate has replaced the Filtros plate used heretofore, being durable and efficient and no more expensive. The experiments in mechanical agitation being conducted at the Des Plaines River Works have not been carried far enough to arrive at conclusions. In view of the very general adoption of diffusion by compressed air in the United States while in England much attention has been given to aeration by mechanical agitation, it is believed that experiment along these lines should be profitable in this country. This is especially the case, as a large part of the operating cost of activated sludge plants is due to the power used for aeration and agitation, while it is admitted that the efficiency is very low, most of the air escaping without change. Efforts looking to a more economical use of air seem likely to result eventually in lowering the cost of power, whether by more effective baffling, by decreasing the submergence of the diffusers, as is attempted at the Des Plaines River Works, Chicago, and at San Bonito, Tex., or by surface agitation.† An element of cost is the area required and as surface agitation implies shallow tanks it usually means a larger acreage which, to that extent, is a disadvantage. Climatic conditions should also be considered in the northern United States,

†Another method, called the "Stream-Flow Process," in which the natural aeration of a shallow stream is simulated, is described by Jenks and Levine on p. 381 of this issue of "Water Works and Sewerage."

where large areas of shallow tanks might present difficulties.

In the plants visited the amount of air required was generally between 1 and 2 cu. ft. per gallon of sewage, the lowest requirements being at Milwaukee (0.95), Calumet (0.9), Des Plaines River (1.25), Indianapolis (1.1), and Pomona (1.3), and the highest being at the two plants at Houston (2.0), and Grand Canyon (about 4). It will be noted that in general plants employing "spiral flow" use less air than those on the "ridge and furrow" system, but the bare figures may be grossly misleading without considering the other uses to which air is applied at the plant, such as for air lift (Grand Canyon, Houston) and sludge filters (Pasadena). The excessive use of air at Grand Canyon is due to the disproportionate capacity of the blower.

A strict comparison of cost between the several plants should also be taken with reserve as locality, size of plant and many other factors enter, but such as have been obtainable are given in Table III.

Sludge Disposal.—The disposal of sludge in lagoons, like the old-fashioned cess-pool, is not always a nuisance and yet cannot be considered ideal or free from possible odor. Where remote from habitations, as at Indianapolis and Houston, it serves without serious objection as an inexpensive expedient.

Prepared sludge-drying beds, as found at the Calumet and West Side Works, Chicago, Antigo, Lodi, Pomona and Harbor City, are less objectionable and with well digested sludge should be fairly free from odor. To prevent the spread of odor from fresh sludge the beds can be covered with greenhouse construction, as tried out at the Calumet plant, but this adds materially to the cost, and although it has generally been found to hasten drying, experience at the Calumet plant does not seem to have realized expectations, except in so far as it has extended the period when drying may be carried on. So far as known, covered sludge beds have not been adopted for any large plant, where sludge handling operations would offer special difficulties.

The success of the activated sludge process depends upon the building up of floc under aerobic conditions. The role of bacteria in the chemical changes that take place, which is generally considered of prime importance, is not definitely known and by some is not considered essential. But where the sludge is to be dewatered the amount and condition of the floc is a matter of vital importance. At Milwaukee the floc was formerly so broken up by centrifugal pumping as to be unfilterable. This was largely overcome by the substitution of plunger pumps. At the Des Plaines River Works, however, but little difference was noted between the filterability of sludge pumped by centrifugal pumps and that pumped by ejectors. A septic sewage is less amenable to flocculation than one that is fresh. In addition to this it is necessary to intensify flocculation by "conditioning" the sludge—that is, to increase coagulation by means of chemicals. For this purpose sulphuric acid has been generally used in the past at Milwaukee and sulphate of alumina at Chicago, but more recent experience at both plants points to the use of chlorinated copperas or ferric chloride. The choice depends in part on the cost and in part on the condition of the sludge. At Milwaukee all three of the above conditioning agents are used in turn, depending on temperature conditions: sulphuric acid in summer and chlorinated copperas in winter. Ferric chloride, tried at the Calumet plant, appears to be yet more effective in producing high rates of filtration but its cost has generally precluded its regular use. To promote filtration and drying, "Filter Cel," a diatomaceous earth, is used at Pasedena. Its effect is purely physical but it is effective in promoting filtration. For eastern plants freight charges would preclude its use, and a further disadvantage is in the dilution of the fertilizing ingredients of the product, "Milorganite" from Milwaukee containing about 7 units of nitrogen as compared with 5½ units in "Nitroganic" from Pasadena.

In the matter of dewatering, the modern Besco-ter-Meer centrifuge was found satisfactory in some respects with activated sludge at Milwaukee but was abandoned on account of the cost and the large amount of fine suspended matter in the effluent that had to be returned for treatment. After experiments with various devices the Oliver filter has been adopted at Milwaukee, the Calumet plant, Chicago, and Pasadena, the Berrigan press at the Des Plaines River Works, Chicago, and at the North Side plant at Houston an American continuous vacuum filter is being installed. By these devices the moisture is reduced to a point between 75 per cent and 80 per cent, so that further drying by heat can be economically carried out.

Table III

	Cost of activated sludge plant construction. Per m.g.d. capacity	Operation‡ per m.g.
Chicago—North Side	$ 97,000†	.....
Chicago—Des Plaines River	252,000††	.....
Indianapolis	40,500	$ 9.73
Milwaukee	99,000	16.80
Lodi	75,000	21.30
Pomona	80,600	25.90**
Pasadena	86,500	67.98**
Harbor City	37,000	.....
Grand Canyon	485,000*	475.60
Houston—South Side	22,000	13.15
Houston—North Side	24,500	17.50

†Exclusive of sludge digestion.
††Including experimental features.
*Including connection trunk sewer and outfall.
**Exclusive of revenue from fertilizer.
‡Exclusive of fixed charges.

The filter cake is dried in Atlas dryers at Chicago and Milwaukee and in Ruggles-Coles dryers at Pasadena. At Houston Buckeye dryers are being installed. The product from the dryer is ground, sifted and sold at Milwaukee at a net price, exclusive of freight, of of about $15 per ton,†† at Chicago $25 per ton, in carload lots, and at Pasadena $32 per ton, f. o. b. cars.

The manufacture of fertilizer from activated sludge requires considerable capital outlay and careful technical skill as well as educational work in building up a market, but the inherent value of the material is such that the revenue from sales under present conditions should about offset the cost of manufacture where transportation facilities are good and the market not too distant.

Chlorination. — Chlorination of the effluent is carried out at Lodi, Pomona, Pasadena and Grand Canyon, in the first three instances to protect irrigated land from any germs of disease that might survive and at Grand Canyon for the drinking purposes in place of the restricted water supply. The situation in each case is exceptional and the expense of chlorinating an activated sludge effluent from which practically all pathogenic organisms have been already eliminated would not under ordinary conditions be justified.

††$22.50 (more recently $25.00), including freight charges.

Uniform License Requirements for Plumbers

Uniform license requirements for plumbers in Bergen County would result in a reduction in building costs, according to M. W. Cowles, sanitary engineer of the Hackensack Water Co., Weehawken, N. J.

"One large item of expense to plumbers is the necessity of securing licenses in each community," Mr. Cowles says.

"In some cases this means the payment of a yearly fee; in others a bond must be deposited in addition. This condition sometimes arises because local plumbers wish protection against craftsmen from other communities where license fees are lower.

"Many builders require competitive plumbing bids, and cost of licenses frequently adds to the expense of the work. A plumbers' examining commission, county or state, would make it possible for any plumber so licensed to work anywhere in Bergen County.

"This would not in any way react unfavorably to the local man, who is in a position to do the work most reasonably."

The water company, Mr. Cowles says, advocates uniformity in plumbers' licenses as part of a generally uniform code of plumbing requirements in the seventy municipalities of Bergen County. Such a code, experts claim, would eliminate unnecessary building expense and safeguard health by requiring conformity to the latest plumbing practice.

Valuation of Public Utilities for Taxation

Impartial and Constructive Sketch of the Fundamentals of the Plan

By L. D. McPHERSON
Attorney at Law, Chicago, Ill.

THE constant concern of the people about the age-old and ever-present problems of property taxation warrants lively interest and continued discussion of means for improving the distribution of necessary taxation burdens.

Ambitious men are able to so disguise selfish propaganda as to make it appear to the voters that property tax burdens will be shifted to wealthy groups or corporations for whom it is difficult to arouse popular sympathy.

A full and fair discussion should lead the people to a clear understanding that this is a delusion and that it is futile for them to increase the property taxes of such groups and corporations because practically all of such increases will be added to the cost of capital or service which the people must use.

Under the laws of many states steam railroads and other public utilities are subject to ad valorem taxation. This requires a valuation. Under the laws of some states additional consideration must be given to the taxpayers' ability to pay.

In determining the valuation and basis for taxation of all such public utilities such items or elements as original cost, investment in facilities, cost of reproduction new, cost of reproduction less depreciation, capitalization, book value, development costs, going concern or market value of securities, either singly or collectively, should not be given controlling weight.

It is not the purpose of this article to discuss valuation for rate-making or for any purpose other than for taxation. It is here insisted that changes in valuation for taxation should not precede but should follow any changes in valuation for rate-making purposes only after the changed valuation has resulted in a change of rates. Such properties can not have any value which will not vary as their usefulness or capacity to earn varies. The question of the valuation of public utilities for purposes of taxation arises only in states where all property must be taxed on an ad valorem basis. Equity may construe this "ad valorem" value basis to mean commercial as opposed to investment or capital value.

In making a valuation of all such public utilities for taxation, little theory or speculation as to future rates, expenses or other factors should be indulged.

If the profitableness of the operation of such public utilities over a reasonable period of normal years is fairly ascertained, it is good evidence of its value when considered in connection with the prospects for the future and a chance to sell the property and business at a profit. The present and prospective worth of the services of the public utilities to those who will use such services may limit the value of such public utilities. Evidence of the value of such public utilities, whether monopolistic or competitive in character, should be but little, if any, different from evidence required to support valuations of other property. "The worth of a thing is the price it will bring." This embraces all the characteristics of each individual public utility by which it may be distinguished from other property, including relative desirability of ownership.

For taxation purposes the best evidence of the value of any public utility should be the financial results of operation of such public utility's property and business taken as a weighted average over a reasonable period of normal years for the property and business apportionable to the individual state. Before capitalizing the funds resulting from such operations, an interest rate which is high enough to hold necessary capital in the public utility industry should be increased by some percentage, or otherwise, to provide for taxes. Neither the past nor proposed taxes of a public utility should be used in the calulations. One step in the calculation might be to use the ratio of the general property taxes to the market value of general taxable property other than that of public utilities. For example, if it may be assumed that: (a) six (6%) per cent is an adequate interest rate; (b) the rate of general property taxes is $3 per $100 of assessed value; (c) general property is assessed for taxation at fifty (50%) per cent of market value, it follows that the six per cent for interest should be increased by one and one-half (1½%) per cent for taxes, making seven and one-half (7½%) per cent the factor by which to divide said funds to ascertain the approximate value of a public utility.

The justification for resorting to the methods of valuation herein discussed may not be found to exist as fully in the case of purely local monopolistic public utilities such as municipal water plants, local gas companies or in condition where contract ordinances fully define and provide for valuations for specific purposes.

Any method of valuation of public utilities for purposes of taxation should be flexible enough to provide equitable adjustment for, among other things, the following:

(a) The precentage, if any, of their net income which has been fixed as due the state by law.

(b) The part, if any, of the state's tax fund, which has been derived from payments made by a public utility, when such contribution to said fund partakes of the nature of a forced subsidy by the utility to the payment of interest or amortization of principal on public bonds issued or assumed for construction or other aid to competing public or semi-public facilities.

(c) Relative advantages and disadvantages accruing to public utilities, or their competitors from recent advancement in the arts, or obsolescence in the facilities of either, when the services, or cost thereof, as performed by either is thereby affected.

Public utility valuations are made for various purposes. These valuations are used by various boards and commissions. For example, the Board of Equalization of the State of Montana is obliged to fix valuation of railroads within the State of Montana for taxation purposes. They have had several different methods suggested as to the proper way of arriving at such value and are giving earnest consideration to the suggestions for the purpose of determining which method is fair to the railroad companies as well as to the state.

In Montana the railroads pay an ad valorem tax. They do not pay, as in some states, a tax based upon their gross revenues within the state, but, in addition to the ad valorem tax they pay a corporation license tax of one per cent of their net proceeds derived from their business transacted in Montana.

The Supreme Court ruling in the O'Fallon case is another example of the use of public utility valuations.

The accompanying article by L. D. McPherson, a valuation counsel, presents a method of valuation of public utilities for taxation purposes.—Editor.

(d) Whether or not the state reserves to itself the exclusive power to tax the public utilities.

(e) The extent to which the valuation of property used in unregulated business as fixed for taxation varies from the fair market or service value of the same.

(f) The extent to which unequal taxes of public utilities affects the cost to them to finance expansions of facilities.

(g) The probabilities that

1. Rates of the public utilities for services are on an approximately permanent level;

2. Volume and classes of their business will continue substantially uniform for a few years.

(h) The honesty, economy and efficiency of the control and management of the public utility.

(i) Expediency, or economy of administration by taxing authorities (comparative cost of collection of the state's revenue at other sources). By preventing the undue shifting of the burdens of taxation from other property to public utilities, state taxing authorities will avoid usurping the duties and powers of state and federal authorities in regulating rates and services.

Ascertaining the financial results of operation of public utilities depends upon accounting and involves the whole responsibility of their control and management.

When the state's revenue is at stake no presumption will be indulged. It may be assumed that all reports, returns, records, vouchers or other documents made or kept by the public utility for its own information or required by law and regulations, state or federal, can by law be made available for, and admissible in, evidence in a hearing on taxation. With broad inquisitorial powers vested in public authorities, officially prescribed accounting for capital expenditures, operating and other receipts and disbursements may be so enforced as to reveal the financial results of operations. It is possible that a restatement of the accounts of public utilities may be required to determine whether or not the revenue has been so handled, for the accounting period adopted for making the valuation, that all changes in tangible property and the financial results of operation would be analyzed in such detail as to afford an accurate basis for a just determination of the profitableness or usefulness of the public utility.

The public utility property, or a distinct or separate unit thereof, for which honest, economical and efficient management can show no financial results of operation, which are beneficial to the owners thereof, should be taxed on no higher than a scrap or salvage value, plus the cost to the state, or its subordinate agencies, of whatever services there is required to be rendered it, including fire, police and other protection. If such public utility become so impressed with the nature of a communal facility, it would thereby be entitled to relief from taxation to this extent.

Apportionment.—If the entire public utility is correctly appraised, there remains the difficulty of apportioning the value of interstate public utilities to the several states served. Danger of duplication always exists because each state within its own realm is independent of every other state. The hardship of decisions which do not eliminate this chance of overlapping is not easily relieved by review, because no evidence will more than tend to prove the portion of the total due to an individual state.

In apportioning, judgment should be influenced by a fair consideration of, among other things, the relative importance, both within and without an individual state, of:

(a) Total units of service facilities involved, such as mileage, and classes thereof, of all lines of railway tracks, telephone, telegraph, transmission and trolley wires, pipes, sewers, conduits, aqueducts, toll roads, including the necessary appurtenances and accessories of each, such as:

1. Land for sites for all such facilties;

2. Substructures, superstructures and equipment of shops, engine houses, power houses, transformers, pumping and relay stations, tunnels, bridges, reservoirs, containers, elevators, warehouses, wharves, docks, office and other service buildings.

(b) The number of units of service performed, such as mileage, per ton, engine, train, truck, taxicab, van or omnibus, car, passenger, crew, loaded and empty movement; cubic feet of natural or artificial gases; kilowatt-hours of electricity; gallons of water, oil or other fluids; number of messages, local and long distance, direct and reverse charges on same, etc., including distances, elevations, curvature or other resistances involved.

(c) The extent to which the services performed by the public utility is monopolistic or is being dispensed with by potential patrons resorting to competing substitutes.

(d) Volume, density and classes, as well as the seasonableness or fluctuations therein of local, through and interline business originated, on, handled over or delivered by the various branches, separable units or trunk line facilities in the several states, the relation of each to the individual public utility's total business and the relative desirability to such public utility of all business transacted.

(d) Whether or not the lines or facilities are branches or auxiliaries, which are only capable of originating business requiring further processing of unfinished products or services for which intervening services by a trunk line are indispensable to the collection for services.

(f) Relation of the actual service demanded of and performed by the public utility to the capacity of the facilities which it must own or control.

(g) Climatic and seasonal disturbances which affect operation and maintenance.

(h) Operating ratios; revenue collected; expenses and damage claims paid.

(i) Fixed rentals paid for use of facilities in the several branches of the service and in the several states.

(j) The relative amount of reserves impressed with obligations for replacement, depreciation, amortization or other sinking funds applicable to the facilities owned or leased in the several states or different branches of the service.

(k) The nature and amount of the liens or other encumbrances, on the parts of the property in the several states or different branches of the service.

Property not used by public utility in the performance of its services to the public, but which is being held for investment or objects not directly connected with such service, should be valued separately from its operated property and taxed on the same basis as if owned or used in unregulated business.

If an easier way, which is just and equitable, can be found to value steam railways and other public utilities for purposes of taxation, it should be adopted.

Ground Water in Southern Idaho

An investigation to determine the geology and underground water resources of the Snake River lava plain, in southern Idaho, has been carried on since May, 1928, by the Geological Survey, Department of the Interior, in cooperation with the Idaho Bureau of Mines and Geology, Idaho Bureau of Reclamation, North Side Canal Co., Twin Falls Canal Co., Minidoka Irrigation District and Idaho Power Co., under the general direction of Harold T. Stearns. The region studied covers over 16,000 square miles. Maps have been prepared showing the direction of movement of the ground water under this vast plain, also the location of the wells from which the measurements were obtained. Many interesting conditions are shown by the ground-water contours — for example, near Idaho Falls, where the ground water is moving westward toward the heart of the desert instead of southward with the slope of the ground surface and the Snake River. These maps are now open for public inspection in the Geological Survey office at Room 232, Federal Building, Idaho Falls, Idaho.

Management and Operation of a Water Works System

General Outline of Methods of Operation at Ottawa, Ont.

By W. E. MacDONALD
Water Works Engineer, Ottawa, Canada

BY instituting a bureau of purchases and supplies it has been found possible to effect substantial savings in the purchase of material and supplies. Requisitions for goods from time to time are made to the purchasing officer in charge of this division and by planning the work, where possible, well in advance, purchases can be made in quantities and when advantage is taken of the low prices that prevail during certain periods when the manufacturers are over-stocked substantial savings may be effected, provided adequate and well located storage space has been arranged for.

Pumping Stations.—In recent years, many factors have largely been responsible in changing the trend of pumping practice. Probably one of the most important changes wrought has been the introduction of the centrifugal pump, which has become a serious competitor of the reciprocating steam engine driven type. The extended use of electricity has witnessed the installation of electrically driven centrifugal pumps as a moderate and convenient means of handling large and small quantities of water under almost every conceivable condition.

In Canada the difficulties of operation in winter through the formation of frazil ice have been greatly lessened by the use of revolving screens combined with the application of steam.

Distribution System.—The distribution system should be designed that it will be capable of supplying adequate quantities of water throughout the entire district for domestic and commercial purposes as well as for fire extinguishment. The cost of a distribution system is usually the largest expenditure of any water works and consequently great care must be taken in both the original design and the extensions as required from time to time.

The planning of a water works distribution system with respect to improvements looking to greater efficiency and more production, is a matter that must take into consideration not only immediate results, but also requirements of the future, when growth and extension of the municipality will call for greater facilities.

New Main Extensions.—In many cities throughout Canada the frost penetrates into the ground for a depth of from 4 to 10 ft. below the surface, necessitating installing mains in many cities west of Winnipeg, with a minimum covering of 11 ft., to prevent mains from freezing. It is important that the engineer should have definite knowledge in advance of the frost penetration in various grades of soil in his own municipality to permit of the mains being installed with a minimum of covering to safeguard freezing, yet avoiding an installation at too great a depth incurring an unnecessary cost.

In regard to the construction work carried out by the city of Ottawa in connection with new water main extensions, where a minimum average covering of 7 ft. is necessary, allow me to set forth the procedure that has been established. When it is proposed to make extensions the engineer in charge has a report prepared with estimates and detailed plans showing the cost of construction, the required revenue and the estimated revenue from the property served by the extension. The work having been duly authorized, the engineer then selects the most competent foreman, and issues an official work order, to which is attached a blue print setting out the new extension, giving the location of all valves, hydrants and specials. These work orders made out in triplicate, contain detailed instructions to the foreman and state definitely the amount of material he is permitted to requisition from the corporation stores. The effect of these orders is to only allow the foreman to receive from stores, the exact amount of material contained in the engineer's estimate and thereby tends to economy. Upon completion of the work, all material and labor is entered on the order and all changes and installations are indicated in red on the blue print and returned promptly by the foreman to the draughting office where a permanent record is made.

Unit Costs.—In addition, the department requires the foreman to make, each day, a complete report of the day's operations which include the following items: The cost of the work performed each day, complete cost to date, materials used each day, and a complete summary of work carried out to date. From these reports the department completes its records in detail, which are submitted to the engineer, and from which he is at once able to make an analysis of the unit costs of all foremen. The effect of these records greatly increases the efficiency of the foremen who soon realize that a permanent record is maintained of their work.

Care in Main Laying.—In the past there seems to have been a tendency to use less care in the construction of the distribution system than was exercised in the construction of any other part of the water works system. This may have been due to the fact that the work was soon covered and out of sight, or from previous lack of experience in good construction practice. Whatever the reason, it has resulted in the development of much trouble often occurring at the most inopportune times and resulting sometimes in heavy property damage and loss of life. Having a previous knowledge of all this the city of Ottawa is most careful in the installation of all mains and services. In this respect I might say that all cast iron pipe gate valves meters and special pipe castings are subject to a standard hydrostatic test before acceptance and must be certified as having satisfactorily met these requirements by one of the official inspection companies. In addition to this as a secondary precaution against the possibility of trouble developing later, the resident engineer is required to see that all pipes and fittings are properly in alignment in the trench, sufficient supports and necessary tie rods in place. When this condition is satisfactory, the pipe must be filled with water and the pressure raised to permit of an examination for any defects previous to allowing any backfilling of trench.

Protection from Frost.—In many Canadian municipalities owing to extreme cold weather conditions in service and main laying it is not always possible to secure sufficient depth of covering to prevent freezing. For example in the following types of construction, where pipes are suspended across rivers, supported on viaducts, intersect subways and tunnels, it is absolutely necessary, in order to secure protection from frost, to have all such pipes and fittings properly insulated.

Insulation.—During the past 15 years the city of Ottawa, like many other Canadian municipalities, has experienced considerable trouble through interruptions to its service with the resultant damage and monetary loss through the freezing and bursting of many large water pipes and valves. This trouble has invariably occurred

during the coldest winter weather, sometimes when the temperature has been as low as 30 degrees F. below zero. To prevent the re-occurrence of this experience the engineering department of our city now insists on that all water pipes, valves and fittings exposed to freezing temperature must be sufficiently insulated against cold to prevent damage by freezing.

Various forms of insulating experiments have been carried out by the department during the past few years but probably the best protection has been secured from the following method:

The pipe itself is wrapped with one layer of hair felt 1 in. in thickness and secured to the pipe with a wrapping of heavy jute twine at 2-in. centers. Over this is applied one layer of heavy asphalt saturated felt secured in place by the wrapping of jute twine. This process is repeated in its respective order until four complete wrappings have been made. On top of the fourth layer of hair felt is placed a close winding of special electric insulating tape to hermetically seal the joints, and when this is finished it is given a treatment of asphalt compound. The insulated pipe is then wrapped first with oiled paper and an additional lining of heavy rosin sized paper. To protect this insulating material against weather conditions the whole is finally enclosed in a jacket of 8 oz. canvas which is treated with a heavy coat of glue sizing and then with two coats of first quality white lead and linseed oil paint.

Maintenance of System.—There are few works which require greater care and more constant vigilance on the part of its employees than does the operation and maintenance of a public water supply. Under the operation and maintenance division there must be considered the following appurtenances: inspection and maintenance of fire hydrants, valves and meters, prevention of electrolysis, regular and systematic survey for the detection of leaks, thawing of frozen services and finally the efficient handling of all general and emergency repairs to the system throughout the 24 hours each day.

Fire Hydrants.—The proper functioning of fire hydrants in all municipalities is a factor which should receive utmost consideration from the authorities in charge. In this connection let me state that I do not consider it good business to pay out, annually, huge sums of money to maintain an efficient fire brigade unless the water works department is maintained on an equally high standard of efficiency.

In Canada particularly, it is necessary to see that fire hydrants are correctly installed to insure proper functioning in service at all times. In the installation of fire hydrants it is highly desirable to see that all lateral connections are equipped with special control valves and laid at a sufficient depth below the frost line to prevent freezing. The hydrants themselves should be plumbed, well set and provision made for drainage through the adjacent sewer. If the foregoing practice is rigidly followed it will be found that the trouble through freezing will be greatly minimized.

However, in many of the most northern Canadian cities, especially with regard to previous installations, it is necessary, during the freezing period that all fire hydrants be inspected at regular intervals. In Ottawa we find it necessary to examine all hydrants in the business area every 24 hours, while the hydrants in the residential sections are inspected every 48 hours. Perhaps one of the most efficient methods of ensuring that this hydrant inspection is properly carried out is to insist on the inspectors marking, in chalk, on the hydrant, the date of inspection and the letter "A" or "P," indicating morning or afternoon. When making the next inspection these chalk marks are effaced by the inspector and the new time and date again indicated in chalk.

Gate Valves.—One of the most important items and one which very often receives but slight attention, is the proper location and maintenance of gate valves. In the city of Ottawa at every opportunity and especially previous to laying of new pavements the department installs sufficient additional valves to decrease the sectional shut down so that at any time it will not be necessary to close down more than one city block. All gate valves are installed in chambers and are inspected at least annually, for the detection of gland leakage and to ascertain if they are in proper working order. At such times the stuffing boxes are packed, gearing lubricated and a test made to determine that the valve is fully open.

Meters.—The sale of water through meters has become now nearly a general practice, resulting naturally in a rapid increase in the number of meters in service, and requiring increased attention be given to their proper care and supervision.

In Canada to date the full benefit of the metered system is not fully apparent as few of the municipalities are 100 per cent metered. However, practically all of the Canadian cities have realized that the selling of water by measurement is the only equitable way and they are rapidly endeavoring to organize this important branch of the service on a proper basis with a view to increasing the number of metered services.

To successfully carry out a meter program in the city of Ottawa, we have built up an organization as a separate branch of the service whose duty it is to test, install, read, repair and systematically record the individual performance of all meters. The records established by this branch of the service have been of inestimable value to the officials of the department in properly administering its affairs in selecting and purchasing the highest quality of meter and in addition, allowing the superintendent to maintain an accurate check on all services so that the water works department is assured of all income justly due.

Electrolysis.—The city of Ottawa has not been greatly troubled by electrolysis owing to the fact that all returns from the street railway power lines have been grounded to the cast iron distributing header. The effect from this has greatly minimized the trouble from this source.

Detection and Prevention of Water Waste.—The problem of reducing the waste of water which invariably occurs in all unmetered cities and towns should receive an amount of attention, from engineers and water works officials, equal to that formerly given to the problem of securing additional supplies, when the demands for water bid fair to exceed the capacity of the source in service.

The three methods most effective in reducing wastes in the city of Ottawa have been as follows:

(a) Regular inspection.
(b) Waste water surveys.
(c) Installation of meters.

It has been found that a large percentage of the careless waste in buildings from defective plumbing and fixtures can be controlled by a systematic interior building inspection by competent and specially trained inspectors in uniform. The work of these inspectors is rigidly backed up by the department and all consumers must maintain the plumbing in a satisfactory condition, otherwise, failure to do so will result in the supply being temporarily discontinued.

In many Canadian cities, contrary to the prevailing practice found in the United States, it is quite common to have the peak consumption occur during the coldest winter months rather than in the warmest months of the summer season. This unusual condition is brought about by the consumers allowing the water to run to waste to prevent freezing. This condition of waste is not one which should be tolerated or accepted in any city as a solution of the cold weather problem of freezing. An effective method of overcoming this extravagant waste has resulted from the work of our uniform waste water inspectors covering the entire city during the cold weather period and reporting to the engineering office all consumers found running water to waste to prevent freezing. On the receipt of the information, the owners are informed by letter that this unnecessary waste of water must cease and that the pipes and fittings must be protected and insulated against cold. These notices usually allow the owner a period of time not exceeding six months to comply with this regulation. The efficacy of this work is well worth while, as demonstrated by the fact that during the past three years we have re-

duced our daily average winter consumption by more than 2,000,000 gal.

The determination of underground leaks and their ultimate repair is a work which occupies considerable time and in the larger cities is best handled by the organization of a separate pitometer branch of men specially trained in this work. As a great deal has already been written on pitometer operations I will not attempt to elaborate on them here, but will state that my personal experience has been that the results of these surveys is wholly dependent upon the initiative and the efficiency of the operator in charge.

Of all means for the reduction of waste there is none more beneficial for securing results than the introduction of high quality meters and all water departments are well advised in working towards a hundred per cent metered supply.

Thawing of Frozen Services.—Until a few years ago probably one of the most vexing questions confronting the officials of a Canadian water department during the winter months, was the freezing of service pipes. The city of Ottawa, during the extreme weather conditions, probably was affected with more frozen services than any other city on the Continent. There have been winters in Ottawa when services of more than three thousand consumers have been frozen and the department in years past was unable to cope with this situation with the result that many hundreds of families in previous years were without water for many weeks at a time. Like all other water works problems requiring action the city of Ottawa took hold of this situation in 1919 and discontinued thawing services by the former unsatisfactory transformer method and designed and constructed four self-contained electric thawing apparati. The success of these new machines has been truly marvelous in rendering a prompt and efficient public service as well as having reduced the cost of each thawing operation from $6.05 per service to $1.78 per service; effecting an individual saving of $4.27 per service. Allowing for all operating costs, interest and depreciation, the thawing machines have been directly responsible in effecting a saving, during the past few years, of $23,000.

I might say that the city of Ottawa has carried on a program of lowering and insulating where necessary, many services where continual trouble from freezing was experienced in the past and this work, together with the new machines, has done much to lighten the burden of the water department during the winter months.

Keeping the Finger on the Pulse of the System.—To definitely insure the service of the department being efficiently maintained at all times during the 24-hour period we have inaugurated in Ottawa, a central headquarters bureau. The purpose of this office is to co-ordinate all the various branches of the water department. At this office all complaints are received and the officer in charge is continuously informed of the working of the entire department, receiving hourly readings of gauges from the pumping stations, transformer stations, and filtration plant as well as pressure gauge readings from all city fire stations. This office is equipped with fire alarm gong, automatic pressure gauge and furnished with a complete set of plans and blue prints of the entire distribution system, giving exact location of all mains and valves.

Emergency Service. — Emergency service is a most important part of the water department's responsibility in safe-guarding the lives and property of the citizens, and the city of Ottawa has placed this service directly under the central headquarters office. To meet this situation we have specially trained employees operating two emergency trucks completely fitted with all supplies and appurtenances. As a means of assistance in controlling breaks within a minimum of time we have had erected at every intersection in the city valve location plates, giving definite information as to the size and location of each valve. These plates have been of great value, especially in the winter season when it is quite usual to have several feet of snow over many of the valve covers.

Confidence Through Publicity.—Municipal officials can make the work of their departments far more effective by taking the public into their confidence. This can best be accomplished by a judicious use of publicity through the daily press in both its editorial and advertising columns; by assuring the public of the safety of the supply; by the encouragement of the citizens to visit the water works plant; and by seeing that the visitors are made welcome, shown over the plant and intelligently advised as to its workings. At all times see that the public are well informed on the services you are performing, for even though you may consider your local organization ideal, the citizens will not consider it so unless you have the press support back of it.

Acknowledgment.—The foregoing is an abstract of a paper presented at the Toronto Convention of the American Water Works Association.

State Sanitary Engineers to Meet in Chicago.—The next meeting of the Conference of State Sanitary Engineers will be held in Chicago, Ill., on Oct. 13, 14 and 15, 1928, with headquarters at the Hotel Stevens. Arthur P. Miller, Butler Bldg., 3 B St., S. E. Washington, D. C., is secretary-treasurer.

London Water Supply

Notes on Chlorination, Prefiltration and Double Filtration

The 23rd annual report of Sir Alexander Houston, head of the water works of London, England, covering the year ended Dec. 31, 1928, is summarized in a recent issue of The Engineer, from which the notes following are taken:

Chlorination of Thames Water.—The period covered by the report is the 13th year during which Thames water has been dealt with by this process. Never since it was begun in 1916 has there been a single instance of complaint as regards taste, though some 76 million gallons are treated every day and some 2,000,000 consumers are each supplied with an average of 38 gal. per day each. Apart from a large saving in coal consumption, since pumping into reservoirs is to a considerable extent lessened, there has, since the introduction of chlorination, been a marked increase in the number of million gallons of water filtered per acre of filter beds cleaned. In the worst case—that of Kempton Park—the increase was from 28.1 to 31.47 millions, and in the best—at West Middlesex—from 35.25 to 67.40, a rise of 32.55. As it costs some £40 to clean an acre of filter bed, it will be realized that the saving that has been effected is very considerable.

During the year an up-to-date liquid chlorine plant, installed at Hampton, took the place of the last remaining chloride of lime plant for chlorination on the board's works. A new factor, too, was the utilization of raw Thames water from the Staines Aqueduct for filtration on the Southwark and Vauxhall filters at Hampton. The water was drawn from the aqueduct at the outlet to the Littleton Reservoir, and passed down the Littleton conduit to Hampton, a special chlorination plant being erected at the Littleton outlet to deal with it. The average dose applied, in terms of available chlorine, was 0.42 part per million. The average cost of chemicals per million gallons treated worked out at 8.8d.

Chlorination of the New River.—Normally, the New River is only chlorinated during the winter months when the water deteriorates considerably in quality, owing, chiefly, to floods, the deficiency of storage accommodation, and, to some extent, to the filtration area being hardly adequate in size. Hence, although the annual reports are now based on the calendar and not the financial year, it was considered advisable that the period covered by the report should be from November, 1927, to March, 1928. Sir Alexander reports that the results obtained were rather remarkable. One hundred and four samples collected at Highfield, before chlorination, contained B. coli in 1 c.c. —or less—in 68.3 per cent of the sam-

ples examined. The same number of samples collected at Wood Green, after chlorination, contained no B. coli in 100 c.c.—or one hundred times as much water—in 85.6 per cent of the samples examined. At the outlet from the Hornsey reservoir the results were practically the same, no B. coli were found in 100 c.c. in 84.6 per cent of the 104 samples. The main point is that the effects of the winter floods, as shown above Highfield, before chlorination, are practically effaced, in a bacteriological sense, by the chlorination process at that station, so that when the water reaches Wood Green it is literally transformed in quality."

It may be added that the total cost of the chemicals used in the New River treatment was £520.54, or at the rate of 1s. 10.8d per million gallons treated.

Pre-Filtration Waters.—Since 1922 all the various kinds of water which "feed" the filters, and which are known as pre-filtration waters—raw water, stored water, gravel water—have been completely and thoroughly examined, chemically and bacteriologically, each week. Sir Alexander remarks that he "feels that the pulse of the metropolitan water supply is the condition of the pre-filtration waters," and he derives some most interesting information from these examinations. For example, he finds that there is an enormous improvement in the bacteriological quality in the raw Thames, Lea, and New River waters, consequent on storage. As an instance, he points out that as raw Thames water contained B. coli in 57.7 per cent of the samples in 0.1 c.c. —or less—and as Chelsea stored water contained B. coli in 100 c.c. in 57.6 per cent of the samples, it might be said that Chelsea stored water was improved 1,000 times. Indeed, from the figures adduced, it is seen that nearly all pre-filtration waters are improved from 100 to 1,000 times as compared with the raw river water. Moreover, it is impossible to store river water without certain physical and chemical changes taking place, and it is possible to read into these alterations of composition, indirect, but valuable evidence of what has taken place bacteriologically. It takes time to effect these physical and chemical changes just as it requires time for the destruction of pathogenic bacteria in water under conditions of storage. From the figures in the tables given in the report, it is obvious that the raw waters are, generally speaking, altered considerably in character by reason of storage, and that the percentage reductions for the various tests are not uniform, the tendency being for the ammoniacal nitrogen, turbidity, and color tests—especially the first two—to show proportionately greater reductions than the albuminoid nitrogen and permanganate tests.

The Barn Elms Experiments.—What are known as the Barn Elms experiments were instituted some years ago to test the effects of passing water, which had previously been treated in primary filters, through an ordinary sand filter at rates up to three times the customary London rate, which is rather less than 2 gal. per square foot per hour. For the purpose, the outlet of one of the filter beds was altered so that this increased rate of flow could be obtained. The chief questions which it was sought to answer were:

(1) Would the filtrate from the altered bed compare favorably, or unfavorably, with the filtered waters generally, as judged physically, chemically, and bacteriologically?

(2) Would there be an increase, or a decrease, in the "number of million gallons filtered per acre cleaned?"

(3) Would there be any evidence of a gradual, but progressive blocking of the interior of the filter, resulting in "the number of gallons filtered per acre cleaned" becoming less and less as time went on?

An adverse verdict regarding No. (3) would mean that practically the whole bed would have to be turned over and cleaned periodically, as, indeed, is the custom at some works of the board. In such a case, everything would depend upon the extent of internal blocking as a result of the "rushing" filtration tactics. So far as the test has been carried, it does not appear, according to the report, that any progressive interior choking of the bed is foreshadowed. Furthermore, as the result of about 52 months' experience, it would seem that the following results can be obtained, assuming comparable conditions, by the methods employed at Barn Elms:

(1) A final product practically as good, on the average, as that resulting from the ordinary slow filtration process.

(2) Comparative freedom from algal troubles, or those caused by an excess of suspended matters, owing to the useful work carried out by the primary filters.

(3) A considerably greater output of water per acre of filtration area, allowing for the space covered by the primary rapid filters, per unit of time.

It may be added that the primary filters have been worked at an average of 141 gallons per square foot per hour, while the experimental filter has been worked at an average of 4.42 gallons per square foot per hour, and has yielded 75.1 per cent of first-class samples, i. e., no B. coli in 100 c.c. water.

Walton Works.—At the Walton works rapid filtration is followed by a filtration, at considerably more than the usual rate, through ordinary sand filters. Raw Thames water is first stored in Walton reservoirs, then filtered — without coagulant — through eighteen primary filters, working at the average rate of 112 gal. per square foot per hour. The next process is filtration through secondary filters working at the average rate of 5.61 gal. per square foot per hour. Finally, the water is chlorinated, the average dose being 0.207 part per million.

The results obtained, as set out in the report, are as follows:

Bacteriological (Average) Results

Number of Bacteria in Agar at 37 deg. C. per c.c.

A. Raw river water 275
B. Walton stored water 15
C. Mixed filtrates from one set of primary filters 18
D. Mixed filtrates from other set of primary filters 21

Filtrates from the Six Secondary Filters Before and After (in brackets) Chlorination

E. No. 1 Filter 2.8 (2.7)
F. No. 2 Filter 5.4 (4.3)
G. No. 3 Filter 3.3 (2.7)
H. No. 4 Filter 5.8 (4.3)
I. No. 5 Filter 3.4 (2.9)
J. No. 6 Filter 5.3 (4.9)
K. Final filtrate from the general filter well (mixture) of all the chlorinated waters 3.7

Percentage Number of Samples Containing No. B. Coli in 100 c.c. (First-class Samples)

The results are given in the same order as in the foregoing:

A. 0.0 (91.6 per cent contained B. coli in 1 c.c. or less).
B. 34.5.
C. 45.0.
D. 51.4.
E. 92.3 (99.1).
F. 89.9 (100.0).
G. 83.2 (98.1).
H. 89.1 (100.0).
I. 93.9 (99.1).
J. 76.3 (93.5).
K. 96.4.

It is explained that the results, as regards A, B, C, D, and K are for the calendar year 1928. The results for E to J are for the period Jan. 1 to Nov. 9 inclusive; afterwards the place of chlorination was altered to allow for the addition of ammonia before chlorination, the mixed water from all the filters being chlorinated at one spot, before going to the general well.

"Bacteriologically, it would be hard to surpass these results," remarks the report. "To change a water containing B. coli in 1 c.c. in 91.6 per cent to one yielding no B. coli in 100 c.c. in 96.4 per cent of the samples examined is a striking feat."

The report gives much further interesting information regarding these works, and the experiments made with the filters, as well as several further tables. We can, however, only spare space to quote the final paragraph in this section: "In looking through these results many items catch the eye; for example, the very high rate of filtration in the case of the primary filters (112 gal. per square foot per hour). The high rate of filtration through the secondary filters (5.61 gal. per square foot per hour), having regard to the much lower rates commonly employed. Finally, the remarkably high number of million gallons filtered per acre cleaned (576 m.g.)."

Equipment for Electrically Driven Pumping Stations

A Method of Improving Operation and Securing Economy at Low Cost

By R. L. BALDWIN

Of Burns & McDonnell Engineering Co., Kansas City, Mo., and Los Angeles, Calif.

MANY small cities have direct pressure systems for water supply. Where steam driven pumps are used it is possible to vary the speed in proportion to the quantity of water required thereby maintaining an even pressure.

Where motor-driven units are in use it is difficult to maintain constant pressure since the motor speed of standard equipment is constant. This means that pressure must vary with the discharge and that unfortunately when more pressure is required at high rates of discharge to compensate for friction losses, it is low or inadequate. Such installations are, therefore handicapped with poor pressure regulation. High pressures must be carried at times when not needed in order to have an adequate pressure when large capacity is required. This in turn causes poor over-all efficiency, often being from 30 per cent to 40 per cent, and even less.

Where it is possible the installation of elevated storage on the system solves this question and adds many other advantages. At the outset, the writer wishes it understood that the method of operation proposed in this paper is not a substitute for elevated storage, but that it does give a method of improving operation and economy at low cost and may serve in many cases where the use of elevated storage is not feasible. The paper is an application of the automatic method of operation to the pumping of water with particular attention being paid to improvement of economy.

The Motors.—The use of a variable speed motor may serve in some instances to drive a pumping unit and obtain reasonable efficiency. If a slip-ring motor is used, resistance must be used to obtain reduced speed. Ordinary operation must be at the reduced speed in order to have increased capacity at higher speed for peak demands. This means a high energy loss in the resistors in order to obtain this speed control and a corresponding low efficiency.

A motor of the brush shifting type offers good efficiency at all speeds but it has serious speed limitations. The manufacturers have not encouraged its use for such service. Up to this time such a system has not been found economically feasible.

The use of pole changing devices for the variation of motor speed for this purpose causes too great a change in speed at each change. It has been used in some installations but is not generally suitable for a direct pressure system.

Boosters.—Boosters are often used where an increase in prassure is desired for short periods. In the ordinary system it is desired to maintain a satisfactory pressure on the distribution system. Very often a transmission main is required to convey the water from the pumping station to the distribution system and this involves high friction losses at times of maximum discharge. Boosters when used are usually designed for a fixed discharge and pressure to care for the maximum discharge and pressure desired.

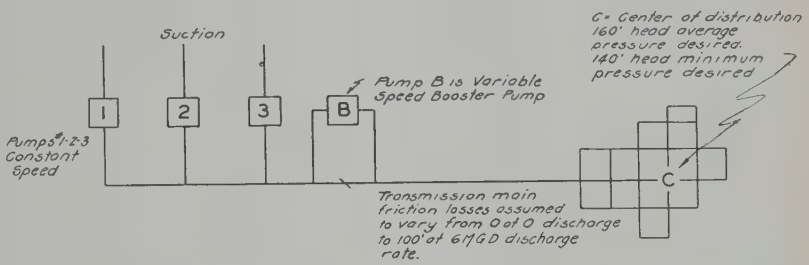

Suction
C= Center of distribution
160' head average pressure desired.
140' head minimum pressure desired
Pump B is Variable Speed Booster Pump
1
2
3
B
Pumps 1-2-3 Constant Speed
C
Transmission main friction losses assumed to vary from 0 at 0 discharge to 100' at 6 M G D discharge rate.

Fig. 1—Layout of Assumed Pumping Station

Another method might be used, namely, two or three ordinary centrifugal pumps driven by constant speed motors with a booster of variable capacity and pressure designed to take care of friction losses. In this way the base load pumps could be operated at a maximum efficiency and the low efficiency would be on the booster pump alone. At low rates of discharge necessitating low speeds, the efficiency of the booster would be low but it would carry only a small portion of the load and hence would not affect the overall efficiency much. At the high rate of discharge when the friction is increased and becomes a larger portion of the total load, then the higher speeds are required and the overall efficiency is better.

Assumptions.—In order to determine the overall economy of pumping with such an arrangement, a case has been assumed where it is desired to maintain a pressure on the distribution system of approximately 160 ft. head and not less than 140 ft. head. The friction loss between the pump station and the center of the distribution system has been assumed to vary from zero at no load to 100 ft. head at the maximum rate of discharge.

Operation on the flat portion of the head capacity curve for a centrifugal pump means fairly constant pressure, but the range of constant pressure operation with a single pump and with reasonable efficiency is very limited. Hence it is wise to use at least three units as they may be suited to the load more closely. An average pumpage of between 2 and 3 M.G.D. is assumed and standard single stage centrifugal pumps designed for heads and capacities as follow are used:

Pump No. 1—1 M.G.D. at 160-ft. head,	50 hp.,	1,800 r.p.m.	motor
Pump No. 2—2 M.G.D. at 175-ft. head,	75 hp.,	1,800 r.p.m.	motor
Pump No. 3—3 M.G.D. at 160-ft. head,	100 hp.,	1,800 r.p.m.	motor

The second is designed for a slightly higher head to take care of friction losses as it is desired not to connect the booster until more capacity is needed. The booster can use a standard centrifugal pump driven by a wound rotor motor of 125 hp. capacity, 1,200 r.p.m. With the friction losses at various rates of discharge known a pump can be selected so that it can be operated to exactly absorb the friction losses by varying the speed of the motor as required.

All of these pumps and motors are standard pieces of apparatus and their operating economy can be readily obtained at various loads and speeds. Reference to Fig. 1 shows diagrammatically the assumed layout. Figure 2 shows curves giving the characteristics of the booster pump at different speeds. These same data for the constant speed pumps are given in Fig. 3.

Method of Control.—By proper selec-

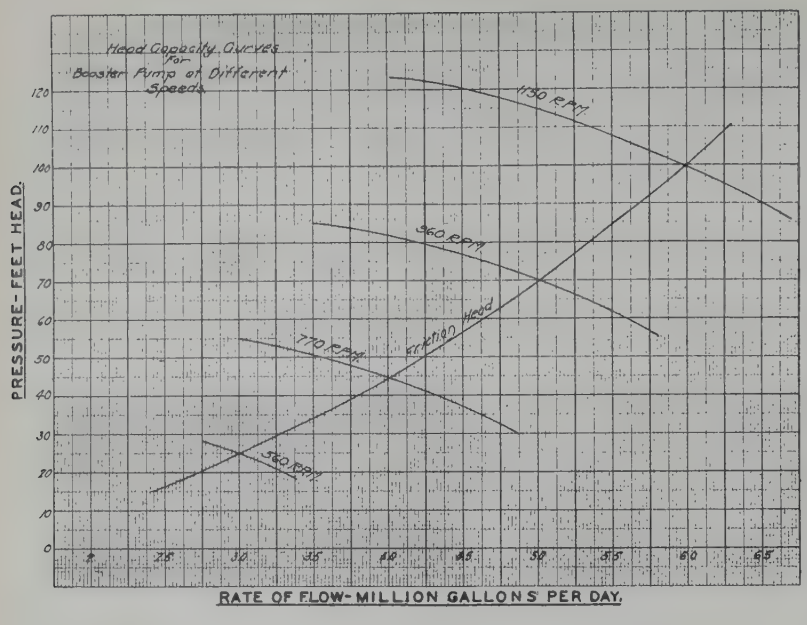


Fig. 2—Characteristics of Booster Pump at Different Speeds

Table No. I—Operating Data for Constant Speed Pumping Units

Rate of Pumping in M.G.D.	Pump Operating Numbers	Combined Efficiencies of Pumps Operating	Water Hp. Developed W-1	Total Losses of Unit in Hp. L-1
0	1	0	0	
.8	1	65	23.9	15.9
1.2	1	75	30.2	14.2
1.2	2	75	40.3	19.5
1.6	2	81	51.5	19.1
2.0	2	82	59.0	20.7
2.3	2	75	63.5	30.4
2.3	3	60	74.3	63.0
2.6	3	73	79.5	36.5
2.9	3	79	84.5	34.3
3.4	3	80	86.0	31.0
3.4	1-3	69	103.0	63.0
4.0	1-3	79.5	111.0	44.6
4.6	1-3	80.0	117.0	45.5
4.6	2-3	74.0	142.0	71.0
5.2	2-3	78.7	145.0	60.6
5.6	2-3	76.5	142.0	63.6
5.9	2-3	74.0	140.0	70.0
5.9	1-2-3	78.0	165.0	70.0
6.0	1-2-3	78.3	172.0	72.3

tion of the head capacity characteristics of the two small centrifugal pumps the pressure at the center of distribution may be maintained within reasonable limits without the expedient of the variable speed unit. These two units may be brought into operation or taken out of operation as may be desired by means of a pressure regulator type of control—pump No. 1 being cut out of operation when pump No. 2 is started. For this combination of pumps the rates of discharge at which pumps are started are shown in Fig. 3. The minimum pressure desired at the center of distribution determines the rate of discharge at which each pump is put into service. In this case a new pump of greater capacity is started when the pressure maintained at the center of distribution drops to 140 ft. head.

The variable speed unit will be put into operation when pump No. 3 is unable to keep the pressure above the minimum desired, and will operate at all higher discharge rates. Its speed can be varied by variation of the resistance in its secondary circuit using a motor-driven rheostat, the control being somewhat similar to that used for control of field rheostats on large generators to maintain a constant voltage.

Pilot wires can be used to connect the pump station to the center of distribution so that the entire control can be operated by that means. The loss of head through the metering device can also be used if desired as it is proportionate to the discharge, however, due to the variations in friction losses due to variations in the point of use in the distribution system, the method of using the pressure at the center of the distribution for control is preferred.

Calculation of Efficiency of Operation.—The efficiency for any discharge up to the rate at which the booster is cut into operation can be easily obtained from the ordinary data obtainable for both pumps and motors. When the booster is in service, the losses in the rheostat must be added to the losses in the motor. In order to make this study of efficiencies, an operating scheme must be set up for the different pumping units. Table I shows the pumps operating for various rates of discharge desired, with the efficiencies for the pump operating or the combined efficiency if two or more pumps are operating, the water horsepower developed and the total losses expressed in horsepower.

Table II shows the operating data for the variable speed unit. It gives the speed for different rates of discharge, the water horsepower, the power input and the total losses expressed in horsepower.

The total overall efficiency of the pumping installation is defined here as the ratio of the total water horsepower to the total power used by the motors including all resistance losses. The

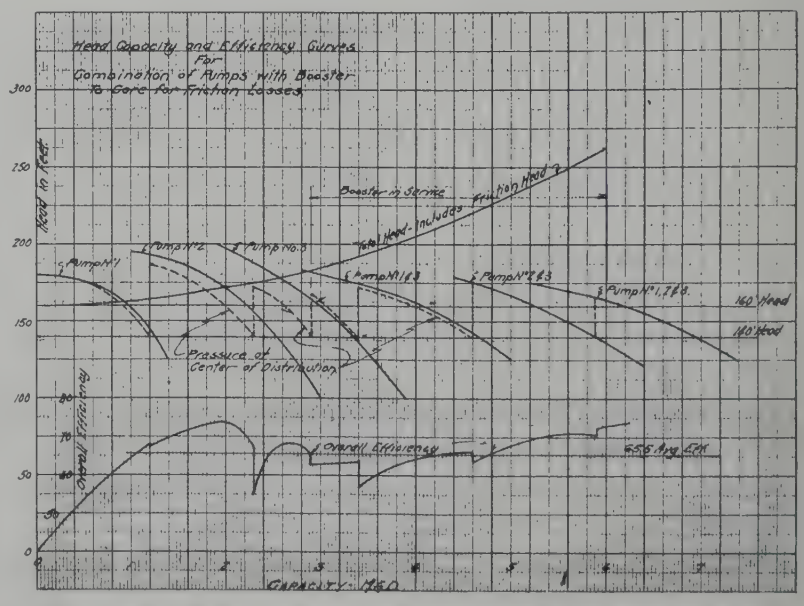


Fig. 3—Head Capacity and Efficiency Curves for Combination of Pumps with Booster

Table No. II—Operating Data for Variable Speed Units

Rate of Pumping in M.G.D.	Motor Speed R.P.M.	Water Hp. Developed W-2	Power Input Hp.	Total Losses of Unit in Hp. L-2
2.9	540	12.1	16.2	24.0
3.4	640	18.9	24.0	30.0
4.0	770	30.6	37.0	32.0
4.6	830	47.8	58.3	38.1
5.2	1,000	68.0	82.0	34.0
5.6	1,060	84.5	101.0	29.5
5.9	1,130	99.9	119.0	29.1
6.0	1,150	105.0	125.0	29.0

following Table III gives the total water horsepower which is the sum of columns designated as W-1 and W-2 in Tables I and II. The column marked total losses is the sum of the losses for the constant speed pump and the variable speed pump given in Tables I and II under columns designated as L-1 and L-2.

The water horsepower plus the losses gives the total power required for eacn rate of discharge and from these data the overall efficiency is calculated and is tabulated in the last column in Table III below.

Conclusions.—Possibly better economy could have been obtained at some points by making some slight changes in the pumps selected for this particular case. However, the results obtained from this study are such an improvement over the ordinary direct pressure centrifugal pumping installation that it deserves full consideration where there are limited funds available for improvements.

If it is necessary in some cases to operate centrifugal pumping stations on a direct pressure system with the resulting low economy usually obtained it certainly behooves engineers and waterworks operators to seek some method of improving the conditions. The efficiency indicated here is approximately 65 per cent overall while present operation of direct pressure motor-driven stations is approximately one-half this.

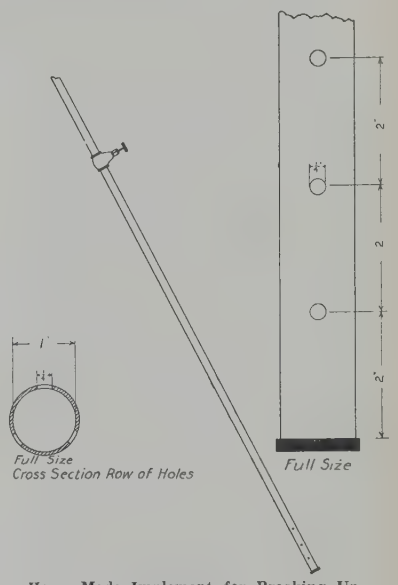
The automatic feature of operation is saving in labor, but above all else it insures that the right pump is operating to obtain the best economy. Where the control is manual, pumps will not be started and stopped at the correct time. Less disturbance to electric and water systems is caused by automatic starting and stopping because it is done in the proper manner and at the correct time.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Breaking Up Mud Holes in a Filter

BY A. L. GOSNELL
Filtration Plant Operator, Laurel, Md.

In a recent discussion a question was asked about using a hose nozzle to break up mud balls in a filter. This same question was asked several months ago at the North Carolina section, A. W. W. A. It was this question that caused me to make the implement that I wish to explain in this article. Instead of a hose nozzle, use a piece of 1 in. pipe about 7 ft. long. Screw a cap on lower end of pipe, and put a 1 in. valve about 1 ft. from upper end. Drill nine ¼ in. holes in this pipe just above the cap, beginning 2 in. above the cap. Space holes 2 in. apart and make three rows with three holes in a row, divided equidistant around the pipe. This completes the nozzle end. It may be well to make the nozzle out of a short piece of pipe, so that in case you wanted to make a change, you could take it out and replace it with another. Attach a 1¼ or 1½ in. hose from this pipe to the high pressure water line. When ready to wash a filter, place a piece of 2 in. plank across the wash troughs to stand on. Start up wash pump, open up high pressure line through 1½ in. hose to nozzle, stand on the plank and push nozzle down through mud pockets while wash pump is running. The nozzle will break up the mud balls and the wash pump will bring them to the surface. It may be necessary to scrape the filter after this is done. Care must be taken to cap the lower or nozzle end of this pipe tight, as otherwise you might disturb the gravel bed. All streams from this nozzle must come out through the sides and not through the bottom. If conditions are such that the wash pump could not be run at full capacity for 5 or 10 minutes, or if there is a considerable amount of mud balls to be removed, open the wash valve about one-quarter way, and work on mud pockets 5 or 10 minutes. Cut out nozzle and open wash valve wide. The wash pump should run at its maximum capacity 3 or 4 minutes after nozzle is cut out. We have been using this home made implement about three weeks and find that it does good work.



Home Made Implement for Breaking Up Mud Balls

Table No. III—Overall Efficiency

1 Rate of Pumping in M.G.D.	2 Pump Operating Nos.	3 Total Water Horsepower $3=W_1+W_2$	4 Total Losses Horsepower $4=L_1+L_2$	5 Power Input Horsepower 5=Col. 3+Col. 4	6 Overall Efficiency in Per Cent 6=Col. 3/Col. 5
.8	1	23.9	15.9	39.8	60.2
1.2	1	30.2	14.2	44.4	68 1
1.2	2	40.3	19.5	59.8	67.5
1.6	2	51.5	19.1	70.6	71.6
2.0	2	59.0	20.7	79.7	74.0
2.3	2	63.5	30.4	93.9	67.5
2.3	3	74.3	63.0	137.3	54.5
2.6	3	79.5	36.5	116.0	68.5
2.9	3	84.5	34.3	118.8	65.6
2.9	3-B	96.6	58.3	154.9	62.4
3.4	3-B	104.9	61.0	165.9	63.3
3.4	1-3-B	121.9	93 0	214.9	56.8
4.0	1-3-B	141.6	76.6	218.2	64.6
4.6	1-3-B	164.8	83.6	248.4	66.2
4.6	2-3-B	189.8	109.1	298 9	63.8
5.2	2-3-B	213.0	94.6	307.6	69.2
5.6	2-3-B	226.5	93.1	319.6	71.0
5.9	2-3-B	239.9	99.1	339.0	70.8
5.9	1-2-3-B	264.9	99.1	364.0	72.5
6.4	1-2-3-B	277.0	101.3	378.3	73.2

Water Company Employes to Wear Uniforms

All employes of the Hackensack Water Co., Weehawken, N. J., whose duties require them to enter homes of consumers will hereafter be uniformed, it is announced by the president of the company, Nicholas S. Hill, Jr.

Inspectors, meter readers, and collectors will be attired in dark gray whipcord with the insignia "H. W. C.," in red, on the right breast, and will wear caps bearing the letters "H. W. C.," also in red.

The purpose of the uniforms, Mr. Hill explained, is to enable customers to identify Water Company employes, and to guard against unwarranted intrusion of homes by imposters who in the past have not infrequently posed as representatives of the company.

In deciding to adopt uniforms, the company acted upon the unanimous recommendation of its departmental heads.

Aggregates for Sewage Disposal Plants

Characteristics and Behavior in Practice of Three Materials

By HERBERT F. KRIEGE
In Charge of Tests, France Stone Co. Laboratories, Toledo, O.

WITH the increase in population about many centers the welfare of the growing communities depends upon the proper control of sanitation and hence to a great extent on effective sewage disposal. The types of disposal systems most widely used in this country are those employing contact and trickling filter beds. In both of these types, mineral aggregates are used as media for the beds. It is the purpose of this paper to discuss the characteristics and behavior of the various materials utilized in this connection in terms of conditions imposed upon them by usage.

The earlier types of sewage disposal systems, other than mere dilution in large streams or bodies of water, consisted of areas of sand or other small material over which the sewage was allowed to flow intermittently, thus exposing it to greater oxidizing and bacterial activities than it received upon slight dilution. As the quantity of sewage increased, the contact process was improved so as to consist of a well-defined area provided with good under-drainage and containing a mass of grosser mineral particles such as broken stone, slag, gravel, cinders, etc. The system as now used permits the slow filling of this contact bed with sewage which has previously had its heavier solids settled out, the sewage remaining in contact with the medium of the bed for a period of time, after which it is allowed to drain away through the under-drainage system. During this time of contact, a certain degree of stability has been reached through the partial oxidation of the organic substances contained in the sewage by the bacterial colonies lodged on the surfaces of the medium.

The contact method, though by no means discontinued, is giving way to the trickle filter bed system. This consists of an enclosed bed of aggregate, usually stone or slag, over which the sewage, after settling or treatment in the Imhoff tanks, etc., is sprinkled by means of sprays or traveling distributors. The sewage thereby receives some aëration before it comes in contact with the bacterial life on the medium. At all times in a properly functioning trickle filter bed, the large voidage provides for sufficient aëration to keep the bacterial colonies and sewage supplied with the oxygen demanded in the biochemical processes. During the time interval required by the sewage to trickle down the aggregate mass to the under-drain, a sufficient stability has been effected in the sewage to permit its passage directly into even small streams without creating a nuisance. The capacity of the trickle filter system is quite large, and hence this serves in congested areas as a satisfactory and efficient sewage disposal method.

Trickling Filter Systems—The distribution of the trickle filter systems through the United States is rather wide. According to the 1927 Progress Report to the American Society of Civil Engineers the Filtering Materials Committee of the Sanitary Engineering Division found that in 19 states east of the Mississippi River a total of 142 plants were in use serving a population of 2,800,000. West of the Mississippi River, nine states reported a total of 246 plants serving a population of 1,240,000, making a combined total of 388 plants serving 4,040,000 people in the 28 states reporting prior to April, 1927. Since that time a survey by the author has added 97 plants, serving an additional population of 754,950, making a total reported up to April, 1929, of 485 plants in 34 states. The distribution of these plants is stated more specifically in Table I.

Table I.—Installations of Sewage Filter Plants Reported with Approximated Population Data

States East of the Mississippi River

State	All Plants Reported Number	Approximate Population
Alabama*	1	80,000
Connecticut*	1	6,000
Delaware	2	4,100
Georgia*	4	385,000
Illinois	34	453,200
Indiana*	5	30,000
Kentucky*	2	53,000
Maryland	10	615,600
Massachusetts*	4	304,000
Michigan	9	96,400
Mississippi	1	11,000
New Jersey*	18	103,600
New York	25	214,400
North Carolina	12	60,350
Ohio	28	590,000
Pennsylvania*	14	76,000
Rhode Island	2	13,400
Tennessee	7	27,100
Virginia*	6	12,000
Washington	1	20,000
West Virginia	2	6,400
Wisconsin	13	70,500
Total east of Mississippi River	201	3,232,050

States West of the Mississippi River

State	All Plants Reported Number	Approximate Population
Arizona*	2	13,700
California*	14	49,700
Colorado*	4	20,500
Iowa*	38	94,300
Kansas	19	82,600
Minnesota	6	45,300
Missouri	22	131,600
North Dakota	2	24,500
Oklahoma	45	318,000
Oregon	1	10,000
South Dakota*	9	54,700
Texas*	122	718,000
Total west of Mississippi River	284	1,562,900
Grand Total	485	4,794,950

*Data taken from the April, 1927, Progress Report of the Committee on Filtering Materials, Sanitary Engineering Division of the American Society of Civil Engineers.

The volume of mineral aggregate entering into the trickle filter beds in the states reported amounts to 1,500,000 cu. yds. Therefore, these sewage disposal systems constitute a considerable market for aggregates, especially since the materials used are combined within rather close limits to one size.

Types of Aggregates—The aggregates which have come into most general use in both contact and trickle filter beds are broken stone, including both sedimentary and igneous rocks, blast-furnace slag and occasionally gravel, cinders, broken tile, broken retorts, etc. This variety in types of aggregate has been brought about by the desire to find some medium which would give a large effective surface for lodgment of bacterial life and yet would be an economically possible material. Experience has shown that certain of these aggregates are distinctly superior to others as to durability and general effectiveness.

In considering the requirements which the medium in a trickle or contact bed must meet, the conditions imposed by such usage need discussion. In practice the medium is intermittently wetted with the sewage and allowed to drain. This facilitates any disintegration or attack which hydration and oxidation under moist conditions might bring to pass. The action becomes particularly severe when during the winter months the aggregate is repeatedly frozen while wet and thawed by subsequent applications of the warmer sewage. In the trickle bed a dosing period of three to six minutes followed by a rest period of ten or fifteen minutes is not uncommon. This means that in twenty-four hours the filter bed medium may be alternately frozen and thawed nearly one hundred times, provided the temperature of the air is well below freezing. This becomes perhaps the most severe test which mineral aggregate is called upon to withstand in industrial practice. The properties of mineral aggregates which will enable them to withstand these conditions of intensive weathering will be considered separately.

The rapid growth in all lines of highway and building construction has required a more rigid classification of materials suitable for the work. The characteristics most commonly specified

and tested for in mineral aggregates are hardness, toughness, abrasion, absorption, weight per cubic foot and soundness. It is quite natural, then, that the group of engineers interested in sewage disposal practice should call upon these same specifications and test procedures to determine the suitability of media in sewage treatment. Some questions may be raised, however, as to the advisability of this plan since it may lead to a false conception of what constitutes the best material for this specific purpose. It is perhaps advisable that as much thought be given color, uniformity, crystallinity, fracture, cleavage, and the screen analysis with the percentage of voids of aggregates in the selection of the material. Roughness has been discussed though without any definite recommendations being made since no easy measure for the degree of roughness has been reported.

Hardness.—The hardness as commonly determined for aggregates is the resistance to wear or abrasion under standard conditions as prescribed in the procedure for the Dorry hardness test. The occasions on which either contact or trickle filter media are called upon in practice to show resistance to wear are few, about the only movement which the material passes through being that involved in the placing of the material in the bed. Hardness is no criterion of the durability of aggregates, particularly in the sedimentary stones which find quite general use in sewage disposal work. One of the hardest of the common minerals associated with the limestone deposits of this country is the practically pure silica mineral known as chert. This has a hardness approximating that of quartz, yet one form of it is a readily disintegrating material upon exposure to weather or sewage treatment. Likewise the hardest limestones are very often the ones that show the greatest tendency toward disintegration when exposed. This applies equally well to gravels composed largely of limestone particles. In the case of blast-furnace slag, which may be either dense, medium dense or honeycombed, the dense variety is naturally the hardest and yet this is more apt to show splitting either in actual or in experimental freezing and thawing or in the sodium sulfate test than is the medium dense or the honeycombed slag.

Toughness.—Since toughness is taken as the measure of the resistance of the material to impact, the same conditions referred to for hardness may be applied in this case. Practically the only impact which the material receives is during the placing. Aggregate of but moderate toughness can easily withstand that amount of impact. Likewise aggregates of great toughness often do not show any greater resistance to the disintegrating action of wetting and drying, freezing and thawing, than do those of lower resistance to impact. It does not seem advisable therefore to discriminate against an aggregate of lower toughness value for this reason only.

Abrasion.—The resistance to wear of one piece of aggregate against others and against the walls of the containing vessel is sought for in the standard abrasion test. This characteristic is somewhat allied to hardness and toughness and what applies to them applies also to abrasion. Argillaceous limestone and some chert may be mentioned in this connection since their abrasion losses are very low, yet their suitability for filter bed use may be very seriously questioned.

Absorption or Porosity.—Density in the mineral aggregates entering contact and trickle filter beds has been sought for quite generally, on the supposition that material which absorbs the least water or has the lowest pore space will be the one longest surviving the disintegrating action of freezing while wet. Woolf[1] has recently shown that when all types of naturally occurring aggregates are considered, igneous and sedimentary stones being included, the resistance to disintegration by five sodium sulfate immersions is somewhat in relation to the density of the stone. Unpublished data secured in the laboratory of the France Stone Co. show that this does not hold true when applied to limestones and dolomites and their associated minerals, particularly when the sodium sulfate test is carried to twenty cycles. The relation between the soundness as determined by these tests and the absorption on several hundred samples of such materials is highly irregular.

Weight per Cubic Foot.—From an economic standpoint at least, the weight per cubic foot has some bearing on the use of a certain medium. The purpose of the medium is simply to provide a sufficiently large surface on which the bacterial life may lodge to effectively alter the sewage in contact with it. Hence, the smaller weight of material used to provide this surface, the lower will be the cost, other things being equal. In this way one aggregate of lower density or higher porosity, even though it shows a higher abrasion loss, lower toughness and lower hardness, may be the proper one to use. Since a difference in weight of 500 lb. per cubic yard is not unusual between moderately porous limestones and dense trap rocks or gravel consisting largely of igneous material, it can easily be recognized that the unit weight is a definite factor in the economics involved. On comparing a honeycombed slag with the dense stone, the difference will be even greater.

Color.—While it may appear that color has little if any bearing on the characterization of the material for its use in sewage disposal practice, certain observations which may be made by visual inspection will prove helpful in the selection of the right material. Color is often an index to the chemical composition or the presence of certain minor constituents which may have a bearing on the general properties of the material. Usually the yellows, reds and browns indicate that the material has already been subjected to oxidizing conditions, while the blues, greys and blacks denote the presence of unoxidized substances such as carbon or iron compounds. Material already in the oxidized state may be expected to undergo less change upon further exposure than one in which this oxidation has not yet occurred. The presence of small amounts of silt, clay, beidellite and organic films can be detected more easily by color or luster differences than by any other simple means. In the case of limestones in the central states, some strata having a dull lusterless ash-gray color on fresh fracture may be regarded with suspicion, regardless of their other physical and chemical properties, since usually they show very little resistance to weathering action.

Uniformity.—The lack of uniformity in composition, kind of material, structure, and texture may be taken as an evidence of lessened resistance to the action of weathering. In the freezing-and-thawing experiments or other accelerated weathering tests the first evidences of the disintegrating tendencies seem to occur at points of non-uniformity in the material. Laminations, sutures, imbedded accessory crystals or masses, and inclusions, be they of microscopic or macroscopic size, appear to be the weakest portions of the defense against disintegration of the material. Blast-furnace slag which has every reason to be uniform in composition is a good example of how this uniformity beneficially affects resistance to freezing and weathering in general. These remarks should not be construed to mean that any material which is uniform is necessarily stable and resistant to disintegrating forces. Lack of uniformity however must be given due consideration when characterizing a material for use in exposed conditions. Reference should be made again to some chert whose tendency to disintegrate is so pronounced while its most closely allied mineral, namely, flint, is a common synonym for durability. In a recently published article by the author[2] the instability of disintegrating chert is attributed more to lack of uniformity in mineral structure and to enclosed

Table II—Relation of Type of Medium to Trickle Bed Clogging Tendency

Material	Number of Plants Reporting	Average Total Years of Service	Percentage Showing Clogging
Limestone	51	8	48
Granite, trap	29	7	23
Blast-furnace slag	11	8	18
Gravel	8	6	50

[1] D. O. Woolf, Jr., *Public Roads*, Vol. 8, December, 1927, p. 225.

[2] H. F. Kriege, "The Stability of Chert," Rock Products, Vol. XXXII, No. 9, April 27, 1929, p. 50.

crystallin foreign masses than to any other observed property.

Crystallinity.—Whether a material is holocrystallin, grossly or finely crystallin, crypto-crystallin or amorphous does not seem to have any great bearing upon its behavior in trickle or contact bed use. However, when within a single piece of aggregate the crystallinity changes definitely, such as a zone of gross crystals within a finely crystallin or amorphous mass, or an amorphous clayey seam within a well crystallized mass, such structures encourage disintegration at that point. Since in the preparation of crushed mineral aggregates for the market the weakness of such structures are usually found by the fracture stresses during the crushing operation, not many of these weak planes persist in the finished pieces.

Fracture and Cleavage.—The fracture and cleavage habits of the commercially prepared products have some bearing on their fitness as filter media. The tendency toward slabby pieces is undesirable since this tends to produce a low voidage in the resultant bed due to overlapping of these slabby pieces in layers like shingles of a roof. Those fracture habits which leave the prepared aggregate with angular shapes and irregular surfaces are most desirable. In this property, slag, trap rock, and granite are most commonly in the desired class. Sedimentary stones free from shaley or slatey material likewise fall into this category.

Roughness.—Since roughness largely determines the amount of surface which a piece of aggregate offers, this property should be taken into account in the selection of a medium for purposes utilizing its surfaces. Experiments conducted at Philadelphia[1] to show the relative efficiencies of aggregates varying widely in their shape and roughness brought out the fact that the rougher the material the more efficient it was in the oxidation and stabilization of the sewage influent. The extremes of roughness in materials available commercially are well rounded gravel on the one hand and honeycombed slag on the other. The opinion has been expressed by some sanitary engineers that slag offers too great a roughness, that this roughness tends to hold the bacterial colonies and collected solids too long so that clogging of the bed is produced. The Progress Report of the Committee on Filtering Materials[2] contains some data pertaining to the effect of type of medium on the clogging tendencies. These have been rearranged in tabular form shown in Table II.

It appears, therefore, from actual experience gained with trickle beds operated in widely separated districts that clogging is not so common with highly irregular and rough surfaced material like slag as with the smooth, rounded gravel.

In February, 1929, the author saw the larger of these slag beds reported in the table above as having clogged. At the time of inspection (during a rest period) it was entirely clean, practically the only evidence that it was not freshly placed slag being a general iron stain covering the surfaces of the slag pieces in the zone of the sprays. This stain was apparently due to the iron compounds contained in the influent. A rest period of several months had completely relieved this bed of its clogging material even though it had been heavily overloaded for twelve years with an industrial and domestic sewage which was difficult to treat. Mr. C. C. Hommon,[3] in charge of the Canton sewage disposal plant, after examining all the known trickle beds using blast-furnace slag in the filtering medium, reported 29 on which no clogging had occurred, while 12 showed clogging or clogging tendencies. However, the tendency to clog in the latter cases could be explained in every instance (1) by poor sizing of the material placed in the bed; (2) by excessive loading without rest periods, or (3) by the poor condition of the influent. On the other hand, perhaps the largest gravel bed now in use was observed by the author during February, 1929, and found to be in a very dirty condition, indicating that this may occur even on a bed composed of smooth rounded pieces. Clogging of trickle beds is therefore due to some factor other than the roughness of the surface of the medium.

Little has been definitely learned about the relative roughness of different filtering media. In order to arrive at some fair understanding of this property in limestones known to be different in their fracture and cleavage habits, the following tests were conducted in the France Stone Co. laboratories. It had been previously shown that the fracture habits of limestone persist into the smaller sizes when the stone is crushed. In this way it is possible to study the roughness of any convenient size of material, say of No. 4 to No. 6 sieve size, and use that as a standard for either the larger or the smaller fragments.

The procedure consisted of determining the amount of material dissolved in dilute hydrochloric acid under controlled conditions of temperature, acidity, agitation and time, from a known area of polished surface of the limestone sample. This gave the specific solubility rate for that kind of material per unit surface. This same weight of material of No. 4 to No. 6 size was run under identical conditions. Since solution takes place only at the surface of the dissolving substances, the different amounts dissolved from the polished and the naturally rough pieces were in relation to the differences of the surfaces exposed or in other words, to the roughness. By comparing the amount of material dissolved from a given weight of the stone particles with the amount that would have dissolved had these particles been true spheres, a numerical ratio of roughness (including both shape and surface irregularities) was obtained. Some of the values found in this investigation are given in Table III, to indicate how widely the degree of roughness may vary even within the same class of material, in this case dolomitic limestone.

Table III—Relative Roughness Value of Some Dolomitic Limestones
(Based on a spherical surface as unity)

	Description	Roughness Value
Limestone A	Almost cubical shape with smooth surfaces	1.39
Limestone B	Fairly cubical shape with smooth surfaces	1.60
Limestone C	Fairly cubical shape with rougher surfaces	1.84
Limestone D	Fairly cubical shape with rougher surfaces	1.87
Limestone E	Irregular fracture, angular shape and fairly smooth surfaces	2.01
Limestone F	Irregular fracture, angular shape and irregular surfaces	3.01
Limestone G	Irregular fracture, angular shape and irregular surfaces	3.10

The method is not applicable to slags and other silicates.

Soundness.—Since the characteristic which most largely determines the usefulness of an aggregate for filter bed use is its ability to resist breaking down under the actions and forces imposed by service, several laboratory methods for predicting the behavior of materials in use have been developed. The more successful ones consist of (1) actual freezing and thawing at relatively short intervals and (2) a drying and soaking process in solutions such as sodium sulphate and sodium chloride in which the destructive effect of the crystal growth of the solution contained in the pores of immersed material is used as a measure of its resistance to actual freezing conditions. A more satisfactory method of testing, where time permits, is to expose the material in question upon the surface of some trickle bed in operation and to observe its behavior through a period sufficiently long to warrant conclusions being drawn. This method is being used by several sanitary engineers and aggregate producers.

From a laboratory standpoint, the sodium sulphate test for soundness is perhaps the most acceptable since it involves but little apparatus, labor, or space and results can be obtained within several weeks. An attempt has recently been made by the Committee on Filtering Materials of the A. S. C. E. to standardize the procedure for this test sufficiently to permit the same type of behavior to be found with a material sent to different laboratories for testing. While the results of this work have not

[1]Report Sewage Testing Station, page 120; also William Metcalf and H. P. Eddy, "American Sewerage Practice," Vol. 3, p. 555 (1916).
[2]Loc. cit.
[3]Unpublished report to the National Slag Assn.

yet been made public, it is believed that such an effort is well worth while and that it will show that no consequential variations result if the several laboratories observe the outlined procedure with fair accuracy. The procedure as followed in the France Stone Co. laboratories consists of immersing the samples, which have been dried for four hours at 105° C., in a solution of sodium sulphate which has previously been saturated at 30 to 35° C. and allowed to cool to room temperature. One cycle consists of 20 hours' immersion and 4 hours' drying, the specimens being examined immediately after removal from solution for any signs of disintegration, checking, flaking, cracking, etc. The number of cycles is usually 20, this number having been arbitrarily set as indicating a sufficient degree of resistance to expect long life in actual practice.

The materials which show distress early in the sodium sulphate test are (1) shales, (2) slatey material, (3) stone with carbon seams, (4) limestones with high non-carbonate content and (5) limestones containing chert of the kind which tends to disintegrate. Usually the destruction of these occurs before ten cycles are run, often before the fifth cycle. Blast-furnace slag, granite, trap rock and other igneous materials are noteworthy in their ability to resist the sodium sulphate test. Likewise these same materials show little disintegration in use in the filter beds. Limestones with their wider range in composition, structure and association show all ranges of resistance to this test and to actual weathering.

Types of Disintegration.—There is considerable confusion as to what types of disintegration are most serious to the effective service of the filtering medium. Some fear the crumbling type of disintegration, others the splitting into slabby pieces. Obviously that type of disintegration which provides material either (1) large enough to cause void reduction within the mass of the bed or (2) small enough to be retained by the organic matter near the surface of the bed would tend to lower the efficiency of the filtering medium. In order to describe more fully the types of disintegration which may occur in stone samples, the following key is given, which has been used in recording all the varieties of distress noted in the author's soundness tests. The amounts of material broken off during all of these forms of failing are indicated in grams.

A.....Horizontal split into 2 pieces.
A3, 4.....Horizontal split into more pieces.
B.....Vertical split into 2 pieces.
B3, 4.....Vertical split into more pieces.
H.....Horizontal chips from 1 piece.
H2, 3.....Horizontal chips from 2 or 3 pieces.
V.....Vertical chips from 1 piece.
V2, 3.....Vertical chips from 2 or 3 pieces.
Ban.....Banding failure.
C.....Imminent checking and splitting.
Ch.....Failure around cherty inclusions and limestone contact.
Chv.....Failure across cherty inclusions and limestone contact.
Cr.....Failure of crystals at contact.
D.....Complete disintegration by crumbling, etc.
D1, 2.....Number of pieces showing complete disintegration by crumbling, etc.
F.....Flaking—scaling on any side, horizontal or vertical.
I.....Infilling crumbling.
L.....Laminations failing.
R.....Broken pieces retained in the series to observe further breaking action.
S.....Surface solution effect.
Sc.....Scaling at surface.
Sh.....Shale failing.
Su.....Sutures failing.
OK.....Passed through individual test successfully.

Considerable work has been done by Orton,[1] Staley,[2] Withey,[3] Schlick[4] and other investigators with mineral aggregates and other non-metallic structural materials to find the relationship between the effects of freezing and thawing, either in the natural or the accelerated state, and the laboratory results of sodium sulphate, sodium chloride, magnesium sulphate, alkali and boiling and drying tests. No fixed relationship has been observed, however, the values of one sulphate cycle ranging from less than one to nearly one hundred freezing cycles with different types of materials or conditions of testing. Perhaps the most logical method is that suggested by G. B. Gascoigne,[5] in which the behavior of an untried material is predicted from the comparison of its

[1]Edward Orton, Jr., "A Study of the Proposed A. S. T. M. Tentative Specifications for Building Brick and a Correlation of Their Requirements with Sodium-Sulfate Treatment and Actual Freezing," Proceedings, Am. Soc. Testing Mats., Vol. XIX, Part I, p, 268 (1919).
[2]H. F. Staley, Transactions, Am. Ceramic Soc., Vol. 18, p. 642 (1916).
[3]M. O. Withey, Proceedings, Fourth Annual Meeting Highway Research Board (1925).
[4]W. J. Schlick, Bulletin 89, Engineering Experiment Station, Iowa State College (1928).
[5]G. B. Gascoigne, Unpublished report on trickler filter media.

Table IV—Field Observations and Laboratory Tests of Slag Used as Trickle Bed Media

Plant Location	Operated Since	Disintegration of Material	Weight per Cubic Foot, Loose, lb.	Absorption, per cent	Apparent Specific Gravity	Voids, per cent	Abrasion, per cent	Soundness Behavior OK after 20 Cycles unless otherwise stated	Chemical Composition						
									Silica, per cent	Alumina, per cent	Ferric Oxide, per cent	Manganous Oxide, per cent	Calcium Oxide, per cent	Magnesium Oxide, per cent	Sulfur, per cent
Akron, Ohio	1916	Little evidence of true disintegration	60	2.6	1.98	44.0	16.1	OK	33.10	12.22	1.08	0.88	40.23	7.25	0.64
Amherst, Ohio	1928	None	68	3.8	2.17	49.8	7.0	OK	36.38	11.24	0.70	1.25	43.04	5.51	1.16
Bay Head, N. J.	1916	None	55	5.4	1.87	45.1	16.8	OK	37.04	9.38	0.76	0.79	38.75	12.36	0.54
Battlewood, N. J.	1922	None	58	2.7	2.04	46.5	17.7	OK	35.60	12.70	0.50	0.94	37.58	10.97	0.83
Bolivar, N. Y.	1928	None	61	4.2	2.07	45.0	14.8	OK	36.86	11.70	1.88	1.06	42.32	4.63	1.20
Camp McClelland, Ala.	1918–1919	Little disintegration	63	3.2	2.04	42.6	10.8	OK	38.16	10.93	2.41	0.53	36.93	6.31	0.62
Canton, Ohio	1925	None	58	3.8	1.96	44.4	17.8	OK	34.28	13.30	0.70	1.07	40.05	6.60	1.31
Colwick, N. J.	1926	None	59	6.2	1.88	42.0	16.3	OK	37.56	11.49	1.01	0.86	30.87	14.77	1.06
Dixmont, Pa.	1910	None	63	2.0	2.12	44.0	8.8	OK	36.38	12.91	1.01	0.76	42.71	3.74	0.97
East Aurora, N. Y.	1923	Small amount splitting	62	3.8	1.96	41.9	11.8	OK	36.50	16.78	0.50	0.85	37.71	3.23	1.13
Edgewater Mines, Ala.	1917	No true disintegration	51	5.1	1.85	47.9	17.9	OK	36.64	11.61	0.51	0.48	38.98	8.48	0.33
Edgewater Mines, Ala.	1925	None	51	5.1	1.85	47.9	17.9	OK	36.64	11.61	0.51	0.48	38.98	8.48	0.33
Erie County, Pa.	1924	None	66	1.5	2.29	47.5	13.9	OK	36.72	9.72	0.50	1.14	43.61	8.54	0.90
Fairfield, Ala.	1914	No late disintegration	..	2.6	2.29	....	11.0	[a]	38.60	10.20	1.34	0.76	41.48	5.88	0.68
Glassboro, N. Y	1926	None	57	4.9	1.89	44.0	15.2	OK	36.06	12.19	0.77	1.64	34.20	12.44	1.14
Haddonfield, N. J.	1920	None	56	6.4	1.93	46.0	18.8	OK	36.00	13.14	0.76	0.78	34.11	12.34	0.68
Hammonton, N. J.	1914	None	63	7.8	2.04	43.4	21.3	OK	41.60	12.79	1.01	0.85	29.80	11.63	0.65
Ishkooda Mines, Ala.	1921	None	62	2.0	2.16	47.3	12.5	OK	38.30	11.21	0.51	0.73	40.77	6.45	0.52
Leetonia, Ohio	1925	Little disintegration at surface	59	3.9	1.85	41.9	19.6	OK	32.62	14.44	0.76	0.62	43.46	2.67	0.94
Maple Shade, N. J.	1927	Very little disintegration	58	5.8	1.88	42.8	16.8	OK	36.28	12.43	0.63	1.37	33.88	13.85	1.52
Media, Pa.	1924	None	57	4.0	1.87	43.4	17.8	OK	38.24	12.10	0.63	1.24	36.30	10.09	1.45
Johnson City, Tenn.	1924	None	75	2.7	2.31	40.3	14.2	OK	39.18	5.58	0.64	0.60	34.78	16.14	0.49
Muse, Pa.	1925	None	64	4.0	2.29	48.9	14.7	OK	34.34	13.73	0.57	0.83	42.13	3.35	1.40
Oaklyn, N. J.	1915	None	57	5.7	1.93	44.3	17.2	OK	38.16	11.72	0.70	0.72	34.86	10.82	0.49
Pitman, N. J., Number 1	1917	No true disintegration	61	3.7	1.98	43.3	15.3	OK	36.42	12.75	0.89	1.02	35.23	11.40	0.82
Quakertown, Pa.	1927	None	56	5.7	1.99	47.6	16.8	OK	35.01	12.92	0.38	1.09	35.90	12.71	1.11
Birmingham, Ala.	1926	None	65	2.5	2.14	43.0	7.6	OK	39.04	10.40	0.70	0.58	39.69	6.08	1.01
South Coatesville, Pa.	1916	None	64	4.1	2.00	40.7	24.7	OK	33.68	12.10	2.52	0.39	42.61	2.16	0.91
Buffington, Ind.	1926	None	73	2.2	2.40	44.5	8.4	OK	39.12	11.14	0.72	1.07	42.84	3.74	1.24
Universal, Pa.	1927	None	67	2.6	2.35	46.1	11.7	OK	34.92	13.23	0.69	0.59	42.49	5.10	0.94
Birmingham, Ala., Jefferson Co.	1919	None	..	3.8	2.00	....	9.0	OK	35.34	11.41	1.41	0.56	41.84	7.99	0.49
Westmont, N. J.	1921	None	58	5.3	1.84	41.6	16.4	OK	35.70	13.41	0.33	1.08	38.79	7.35	0.80
Woodbury Heights, N. J.	1922	Marked evidence of disintegration	55	4.7	1.91	46.3	18.3	[b]	34.04	13.01	0.63	0.62	40.78	10.01	0.72
HIGH			75	7.8	2.40	.....	.....	.....	41.60	14.40	2.52	1.64	43.61	16.14	1.52
LOW			51	2.0	1.84	.....	.....	.....	32.60	5.58	0.33	0.39	30.87	2.67	0.33

[a] 1 small chip at eighteenth cycle.
[b] 1 piece in two at twelfth immersion, 1 piece in two at fourteenth immersion, 1 piece 10 in parts at seventeenth immersion and 1 piece in 7 parts at eighteenth immersion. Contained small piece of coke impregnated with iron.

accelerated weathering resistance with that of a material known to be satisfactory both in test and service. Nevertheless it is becoming more evident as our experience with filter media increases that a material which will withstand 20 cycles of the sodium sulphate test as is most widely followed today,[1] can be expected to stand up well for several decades under the severe conditions imposed by actual service in trickle beds.

The factors directly affecting soundness of natural mineral aggregates of sedimentary origin are lack of chemical or physical uniformity within the specimen, more specifically existence of certain associated minerals such as shale, pyrite and some cherts, and the presence of considerable amounts of clayey material, beidellite, and similar hydrous alumino-silicates. The usually considered physical properties of hardness, toughness, abrasion, etc., play but minor parts in determining the life of filter material, as was pointed out in the discussion previous. The disintegration of granites and other igneous materials is so slow that the development of their factors of degradation is unnecessary in this connection.

Sometimes one finds a tendency to specify the chemical composition or some physical property for blast-furnace slag if it is to be considered for sewage disposal bed purposes. Such conditions as low lime, low sulfur, or low iron content are called for, with some thought being given to the density of the material. Slag, by the very reason of its existence, is made to conform to a definite chemical composition within narrow limits. It does not therefore seem the part of wisdom to arbitrarily set standards for slag if its use in a special field like sewage disposal is being considered. Rather it should be taken as it is if tests and use have demonstrated its suitability for that service. In Table IV are found data secured by Fred Hubbard of the Standard Slag Co., Youngstown, Ohio, on slags that were collected by C. C. Hommon from trickle and contact beds in service. It should be observed how little variation there is in these slag samples in both composition and in physical properties, and how uniformly well they have withstood the conditions of actual service and the subsequent 20 sodium sulfate cycles. These figures amply support the statement that the slight variations found in the chemical and physical properties of commercially prepared slag are of no significance to the durability of the material and its quality for sewage disposal beds.

The sole function of the medium in a trickle filter bed is to provide a large amount of well aerated surface. To maintain proper circulation of air within the bed, the medium should have a high percentage of large voids. Hence, if a material has a large specific surface, its excellence for this use will depend upon the factors controlling its voids. These are sizing, cleanliness and durability. In this day when the washing of commercial aggregates is so common, it should not be difficult to secure material of the desired cleanliness. Likewise proper sizing should be entirely within the control of the engineer in charge of the job and the producer of aggregates. Judging from beds now in operation, sufficient attention has not been paid to this matter of sizing. The quantity of fine material below that specified, not infrequently runs to 15 to 20 per cent of the total. This very definitely reduces the voidage of the bed and hence the air capacity and promotes clogging. According to statements of state health officers of several states in the Great Lakes region, improper sizing has contributed more often to the poor behavior of beds in these states than has disintegration of the material after placement.

Size of Aggregate.—A tendency to raise the minimum size of material is evident. Taking the sizes specified for some 50 plants into consideration, the average size of aggregate for the upper part of the bed is found to have changed with time in the following manner: previous to 1910, 1.1 to 2.8 in.; 1910 to 1915, 1.2 to 2.5 in.; 1915 to 1920, 1.7 to 3.2 in.; since 1920, 1.8 to 3.3 in. It is logical to expect a continued increase in the smaller dimension since this will provide for larger voids and less opportunity for imperfect oxidation or for clogging.

Another evil attending poor sizing is the tendency for the fine material to concentrate in portions of the bed during placement unless special care is taken to prevent it. Such areas invite trouble such as pooling and clogging since they offer greater resistance to the downward movement of sewage and the solids carried thereby. If the material has the property of cementation, this will be most apt to occur in such areas of concentrated fine particles. It is doubtful if cementation ever results from the accumulation of fine material broken down from the grosser pieces by disintegration.

Occasionally a trickle bed is reported to be giving unsatisfactory service. Usually the filtering medium is blamed for this condition. However it is well to ask concerning the operating practices of the plant. There are several well-known cases of the unsatisfactory performance of sewage plants in which the trouble was not due to the aggregates. Beds of granite have clogged, pooled and flooded until cleaning was necessary, yet no characteristic of the stone contributed to this trouble. The only explanation lies in the improper operation of such beds. Overloading is the most frequent operation abuse. This factor probably accounts for more trouble than any other.

Poor screening and insufficient settling of the sewage permit excessive quantities of solid matter to pass upon the beds. The accumulation of this foreign material contributes definitely to the clogging of the filtering medium. Surface drainage carrying run-off sediment to the bed constitutes another source of trouble. Unless proper provision is made against it the filter areas may become littered with leaves and similar debris. Each of these operating factors may impair or destroy the efficiency of a trickle or contact bed otherwise in good condition.

Suggestions for Producers.—As practical measures for producers of filter bed media, the following suggestions are offered:

1. Establish the durability of the material by laboratory tests (preferably sodium sulfate) and if possible by observing its behavior on the surface of a bed in operation through one winter. Field observation indicates that the disintegration of aggregate takes place almost entirely at the surface of the bed and to the greatest extent during the first year or two.
2. The inspection and testing of the stone quarry, slag bank, or gravel pit is not of as great importance as the testing of the prepared aggregate of the size desired for that use.
3. Cleanliness and close adherence to the size specified are of the utmost importance. Such attention and effort will involve a slight additional cost, but it greatly improves the quality of the material and makes it distinctly worth more to the consumer.

Conclusions.—The conditions imposed by sewage disposal practice in which mineral aggregates are used in trickle filters or contact beds are very severe. However, aggregates of sufficient durability to be used in this practice are commercially available in most sections of the country. The function of the medium is to provide a large well aerated surface. To this end the proper sizing, cleanliness, placing, and the durability of the medium are of utmost importance. The first three of these factors can be controlled while the fourth can be predetermined with a sufficient degree of accuracy from soundness tests. Twenty sodium sulfate cycles with stone, slag and gravel aggregates indicate sufficient durability for satisfactory service as sewage disposal media. Many beds are now operating successfully in which the material will not withstand 20 cycles. The usually considered physical properties such as hardness, toughness, abrasion, etc., are of minor significance as criteria of the fitness of mineral aggregates in this field. Poor operation of a sewage disposal plant is frequently the cause of inefficient behavior of otherwise satisfactory trickle or contact beds.

Acknowledgment.—The above is a paper presented in the "Symposium on Mineral Aggregates" at the 32nd Annual Meeting of the American Society for Testing Materials, Atlantic City, N. J., June 24 to 28.

[1] U. S. Department of Agriculture Bulletin 1216, p. 8 (1924). Revised form, p. 206 (1928).

Sewage Treatment by Stream-Flow Aeration

An Improvement in the Activated Sludge Method

By HARRY N. JENKS and MAX LEVINE

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FOLLOWING various preliminary conferences, an agreement was effected during March, 1927, between Jacob E. Decker & Sons, of Mason City, Ia., and the engineering experiment station, Iowa State College, Ames, Ia., whereby a cooperative industrial fellowship was established for conducting packing-house waste disposal investigations and research. The writer assumed active charge of the project, to collaborate in the solution of the biological and sanitary engineering problems that presented themselves. Frederick G. Nelson, sanitary engineering graduate of the University of California, was appointed research fellow, in charge of field work at Mason City. Dean Anson Marston, as director of the engineering experiment station, has general supervision of all projects undertaken by the station.

Some time previous to the initiation of this project, the Executive Council of Iowa had taken mandatory action to secure the abatement of gross nuisance resulting from the discharge of industrial waste into Lime Creek, this action being based on the recommendations of the Iowa State Department of Health subsequent to a stream pollution survey completed by the division of sanitary engineering. The degree of treatment to be given the wastes was prescribed and a date fixed by which the Decker company, as one of the chief industries affected by the order, should comply with the new regulations. In order to determine by what means, if any, the proposed standard might be reached, either by a modification of the design and operation of the present activated sludge plant, or by some other process or combination of processes, the Decker company availed itself of the services which the engineering experiment station is in a position to render in such cases, through cooperative research in industrial wastes treatment.

During the course of their investigations relating to the Decker problem, the writers originated and studied experimentally a new means of sewage aeration, in an endeavor to ascertain the suitability of the activated sludge process under the best possible operating conditions. Because the new method simulates more closely than any other the basic phenomena responsible for the natural self-purification of sewage-polluted streams, it has seemed appropriate to designate it as a "stream-sewage treatment process." Systematic studies, both in the laboratory and in the field. have demonstrated the fact that, in practical operation, the stream-flow principle gives promise of furnishing an improved means of treating sewage and other organic wastes, as viewed from the standpoints of efficiency and of decreased cost of construction and operation.

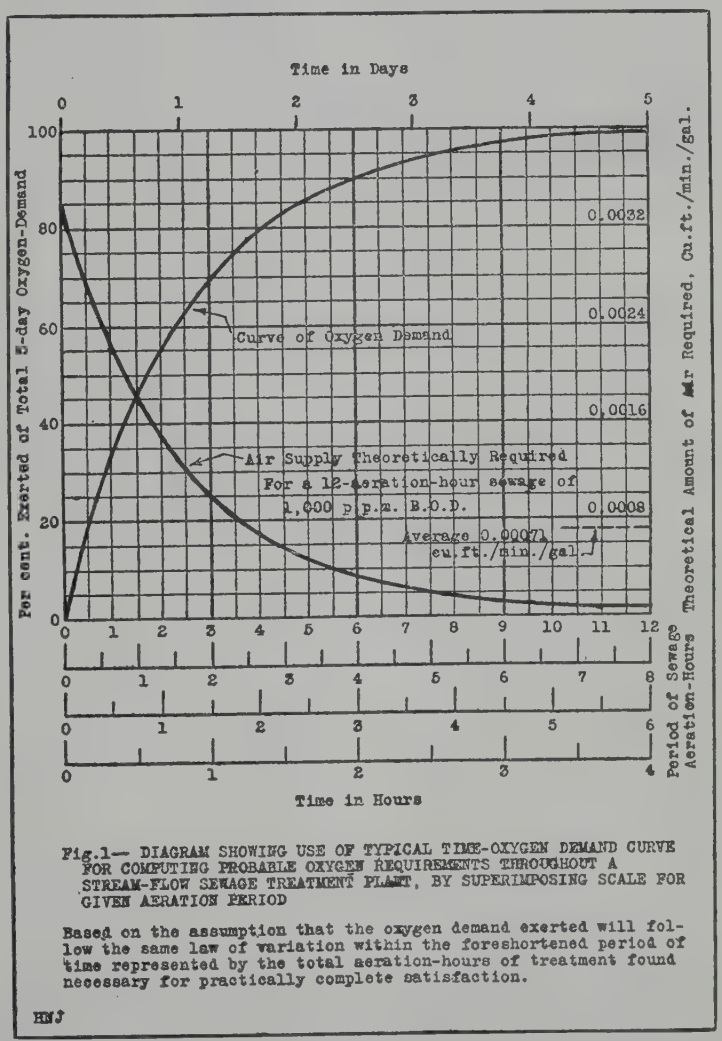

Fig.1— DIAGRAM SHOWING USE OF TYPICAL TIME-OXYGEN DEMAND CURVE FOR COMPUTING PROBABLE OXYGEN REQUIREMENTS THROUGHOUT A STREAM-FLOW SEWAGE TREATMENT PLANT, BY SUPERIMPOSING SCALE FOR GIVEN AERATION PERIOD

Based on the assumption that the oxygen demand exerted will follow the same law of variation within the foreshortened period of time represented by the total aeration-hours of treatment found necessary for practically complete satisfaction.

Fig. 1

Contrasts and Similarities in Aerobic Sewage Treatment.—When sewage is treated aerobically, the chief purpose of whatever process may be adopted is to bring the sewage and oxygen into intimate contact with each other. The present high regard in which the trickling filter is held is due in large measure to the effectiveness of this treatment device in maintaining aeorbic bichemical reactions resulting in a high degree of purification at relatively low operating cost. In the trickling filter the active biologic agents concerned in purification are in the form of a thin film which attaches itself to the filter material. As long as any given portion of this film remains in the filter bed it is stationary. This fact is responsible for a very important characteristic of trickling filters which manifests itself in the definite zoning of the biologic

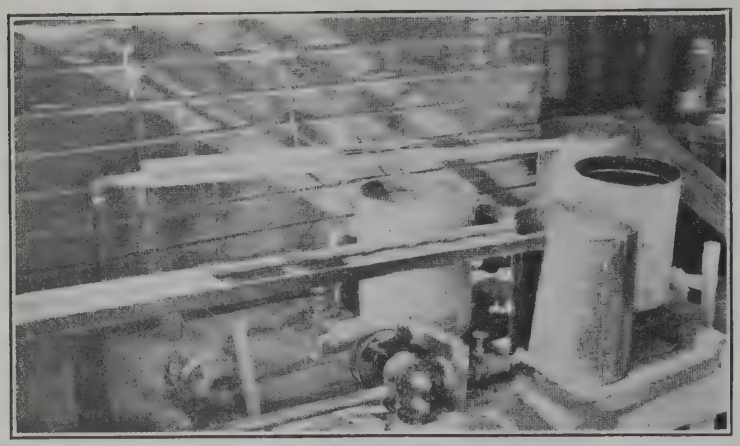

Fig. 2.—Laboratory Stream-Flow Sewage Treatment Plant, Showing Method of Recirculation of Sewage Over Reaeration Surfaces Discharging Into Oxidation Tanks. The Apparatus Is Here Arranged for Biologic Stage Treatment

life within the filter. As the sewage passes downward through the bed, the decomposition products of each stage of purification are successively removed to lower portions of the filter, where these products encounter organisms particularly adapted to the fermentation of such substances. Each zone, therefore, is largely washed free of the end products produced therein, so that these do not interfere with the biologic activity.

In sharp contrast with the trickling filter, the activated sludge process has several inherent disadvantages arising primarily from the fact that the purifying agents must be circulated through the sewage and, as ordinarily carried out, the process does not permit of an orderly biologic zoning, because of the promiscuous mixing of all the living forms that may be present in the activated sludge at any time. These organisms, upon which dependence is placed for the purification of the sewage, are continuously subjected to the inhibitory influences of their own end products until these products are decomposed by other microoganisms, and in each stage of the process the inactive organisms suffer considerable injury. Moreover, it is a difficult matter, when circulating the activated sludge through the sewage, to secure as intimate a contact with the organic matter to be absorbed as is evidently so well effected by the stationary sludge (jelly) adhering to the rock of a trickling filter. Here, also, the active agents are in the form of a thin film, while in the activated sludge process, when the oxygen is brought into the sewage by means of diffused air bubbles, much of the efficiency of surface-film contact is lost.

Finally, when sewage enters a stream and is subjected to the treatment process as evidenced in the self-purification of streams, there succeeds an orderly sequence of stages of oxidation accomplished by the different groups of organisms adapted to the environment present throughout each of these stages. Furthermore, the rate of absorption of oxygen, as defined by the rate of reaeration of the stream, is proportional to the dissolved oxygen deficit, which, in turn, is a reflection of the oxygen demand exerted by the sewage from point to point along the course of flow. In contrast with this situation under natural conditions, the air supplied in the activated sludge process is ordinarily the same in amount from start to finish. The resultant tendency is toward an insufficient supply at the beginning and an excess near the end, or else a waste of air throughout the aeration period.

Conception of Stream-Flow Aeration.—A critical review, such as has been outlined, of the advantages and shortcomings of the principal available methods of aerobic sewage treatment, leads to the conclusion that, in the final analysis, all so-called artificial treatment processes are simply adaptations of those found in nature. Further thought on this subject reveals the close analogy existing between the theory underlying the activated sludge process and the actual biochemical phenomena operative in stream flow.

Although the means which are employed to introduce the required oxygen into the zone of biochemical activity in the activated sludge process are strikingly dissimilar to the absorption of atmospheric oxygen in natural stream flow, yet this contrast is occasioned chiefly by difference in method rather than in principle. Moreover, the relatively short period of aeration, measured in hours, provided in the artificial process, is simply an acceleration of the process of decomposition, extending over a relatively prolonged period, measured in days, throughout which the oxygen demand is being exerted and finally satisfied, in a flowing stream. Taking the natural process as a basis of comparison, it is observed that the advantage lies with the artificial process in respect to the time factor of purification, a result attained by virtue of the presence of the artificially developed activated sludge. On the other hand, it is apparent that in the natural self-purification of streams the direct absorption of atmospheric oxygen without the employment of extraneous mechanical power other than an equivalent small loss of head, coupled with the absorption of such oxygen in proportion to the oxygen deficit only, is a manifestation of the economy of nature which the existing artificial process very imperfectly applies. The truly enormous weight of oxygen appropriated from the atmosphere by streams, through surface reaeration, comes as a surprise to engineers who are aware only in a general way of this phenomenon, and it can not fail to impress any one making the detailed computations required for studies of the oxygen balance in streams.

For some time past, the writers, in common with other workers in this field, have been impressed with the quite evident wastefulness of the present methods of introducing compressed air, through diffuser plates, into the body of sewage passing through the aeration tanks of an activated sludge plant. By waste of air is meant, in the present discussion, the use of air for other than its appropriation by the aerobic organisms for the oxidation of the organic matter. That the amount of air, and consequently the expenditure of power, is greatly in excess of the theoretical requirements for the satisfaction of the oxygen demand is clearly indicated by Fig. 1. On this diagram a curve is drawn showing the air supply theoretically required for an industrial sewage having an initial five-day oxygen demand of 1,000 p.p.m., and is based on the assumption that the rate of satisfaction of this demand will proceed substantially in conformity with the general course of the deoxygenation curve proposed by Phelps and later more fully confirmed by Theriault during the latter's studies on the pollution of the Ohio River.[1] Although deoxygenation in the presence of activated sludge, and the consequent need for oxygen to supply the resulting deficit, may doubtless be found, upon further study, to proceed at numerically different rates than those in the ordinary cases considered; yet the authors have determined that the typical five-day deoxygenation curve quite well defines the general relative magnitude of the oxygen demand during successive periods of time, measured, in the present instance, in hours of aeration. From Fig. 1 it may be observed that the average theoretical requirement for air to remove 99 per cent of the oxygen-demanding con-

[1]Phelps, E. B. (1909): The Disinfection of Sewage and Sewage Filter Effluents. U. S. Geological Survey Water Supply Paper 229, pp. 74-88.

Also Theriault, E. J. (1927): The Oxygen Demand of Polluted Waters. Pub. Health Bull. No. 173, p. 131 et seq.

stituents from a 12-aeration-hour[2] industrial waste of 1,000 p.p.m. initial biochemical oxygen demand is only slightly more than ½ cu. ft. per gallon, whereas the normal use of air in practice might be from 4 to 6 cu. ft. per gallon for such a waste.

Aside from the wide divergence between the theoretical and actual requirements for air for oxidation purposes, the current practice of supplying the same amount of air per unit volume of sewage, from beginning to end of the aeration period, is not in conformity with the fact expressed by Phelps that "the rate of biochemical oxidation of organic matter is proportional to the remaining concentration of unoxidized substance, measured in terms of oxidizability." To take this condition into account requires the introduction of oxygen at the maximum rate at the beginning of the process, followed by a gradual reduction of air supplied, corresponding to the decreasing oxygen demand exerted, until the completion of the aeration period is reached.

Engineering Design of Basis of Stream-Flow Reaeration.—The theory of reaeration and its application to problems of stream pollution encountered in practice have had extensive treatment in current technical literature, notably by Streeter and Phelps,[3] in a classic contribution to our knowledge of the physical factors involved in the self-purification of natural streams. The definite, quantitative relationships discovered by these investigators and formulated mathematically for use in computing reaeration rates furnished valuable collateral evidence as to the correctness of the basic conception for the engineering design of a sewage-treatment plant on the stream-flow principle, presently to be described. In such a plant the oxygen requirements are met through surface reaeration of the sewage under optimum conditions as found in natural water courses.

Streeter's investigation showed that the rate of reaeration, designated by him by the symbol, K_2, is defined mainly by the temperature, oxygen saturation deficit, and the turbulence of the stream. In a sewage-treatment plant employing the stream-flow principle it was conceived that the factor of turbulence should be brought into play to the best possible advantage. Turbulence itself being an abstract characteristic, Streeter defined it in terms of velocity and depth, and determined empirically the validity of the following relationship:

$$K_2 = \frac{cV^n}{H^2}$$

where K_2 = coefficient defining the rate of reaeration;
V = velocity of the stream in feet per second;
H = mean depth of flow in feet;
c = constant depending chiefly upon irregularities in different stream stretches, producing turbulence; and
n = constant defining the variation in reaeration rates in the same river stretch for different flow conditions.

In analyzing the numerical values of (n), Streeter found that, when the channel conditions are such that a 5-ft. increase in stage produces from 2 to 7 ft. per second increase in mean velocity, little change in the value of (n) occurs, its actual value at the upper end of the velocity range being slightly greater than unity. In such a case the influence of the velocity itself predominates over that of turbulence.

Regarding the values of (c), it was concluded that the slope and irregularity of the channel are probably the governing factors. Available data on the Ohio River tend to show that the irregularity factor itself loses most of its effect when the slope approximates 2 ft. per mile. With greater slopes than this, corresponding values of (c) increase at a much more rapid rate.

In concluding his analysis of the factors influencing the value of K_2, Streeter shows that there is a "tendency for K_2 to reach a maximum with increasing velocities of flow up to a certain point. * * * The velocity of flow coinciding with this maximum K_2 point varies in different river stretches studied, but in a majority of them it is reached at somewhere between 2 and 4 ft. per second."

Holding in review the conclusions set forth by Streeter and his collaborators in relation to stream-flow aeration, it is apparent that this natural phenomenon can be directly applied to the treatment of organic wastes by providing an engineering design in which the maximum value of K_2 should be obtained. This object may be reached by means of a controlled section of stream channel in which the proper depth and velocity can be maintained. In natural streams the decomposition of the sewage proceeds over a long course of flow, many miles in length, so that it was recognized that within the physical limits of a treatment plant the necessary time element, in terms of distance traversed, could not be introduced in this way. Accordingly, recirculation of the sewage over the controlled section was decided upon and the design of the plant was made in accordance with the following basic assumptions:

(1) The rate of biochemical oxygen satisfaction will proceed, in the presence of activated sludge, substantially in accord with the deoxygenation curve as derived for flowing streams, except that the biochemical oxygen demand will be fully exerted and satisfied within a foreshortened period of time. (See Fig. 1.)
(2) The effect of reaeration may be closely simulated by exposing the sewage flow in thin sheets to the atmosphere by recirculation over a reaeration surface comprising a controlled stream section distinctly separate from the zone of biologic activity wherein the oxygen so absorbed is utilized.
(3) The rates of recirculation of sewage over the reaeration surfaces at different points throughout the aeration period shall be adjusted to the actual biochemical oxygen demand correspondingly exerted.

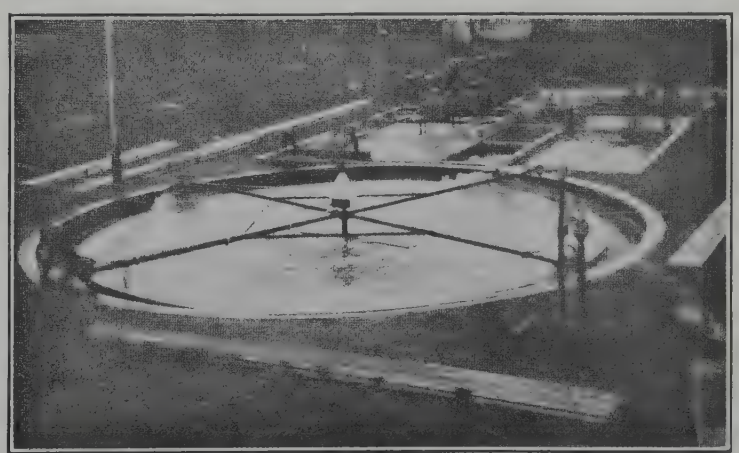

Fig. 3.—Practical Scale Field Installation of Stream-Flow Plant for Treatment of Packing House Wastes. General View of Reaeration Units and the Types of Pumping Equipment Devised for Test Purposes

[2]The term "aeration hours" refers here to the ascertained period of aeration needed to effect the maximum reduction of biochemical oxygen demand of which the process is economically capable when treating the sewage in question. Thus, a sewage requiring six hours' aeration for satisfactory treatment on this basis, may be referred to as a six-aeration-hour sewage.

[3]A Study of the Pollution and Natural Purification of the Ohio River. Public Health Bulletin No. 146, U. S. Public Health Service (1925).

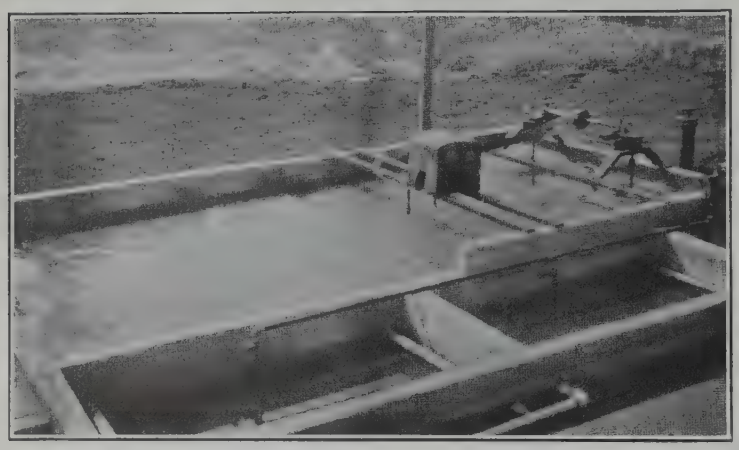

Fig. 4.—View of Primary Stage Aeration Unit of Practical Scale Stream-Flow Sewage Treatment Plant, Showing the Realistic Manner in Which the Recirculation of the Sewage Over the Reaeration Surfaces (to the Right) Simulate the Rills and Riffles of a Rapidly Flowing Shallow Stream. Illustration Shows Propeller Blade Pumps in Operation in This Unit

The physical construction which a stream-flow plant thus assumes was seen to involve essentially a biochemical oxidation zone contained in a tank or basin through which the main body of sewage progresses and a separate reaeration or oxygen-absorbing zone, embodied in a paved surface adjacent to or over the tank, over which an independent and concomitant recirculation of the organic wastes is maintained. The sewage is withdrawn from the oxidation zone, discharged onto the reaeration surface, and allowed to flow down the slope of this surface, thence returning into the oxidation zone within the aeration tank.

In comparing the stream-flow plant design conditions with the relationship $K_2=cV^n/H^2$, it will be noted that the minimizing effect of (H) may be practically eliminated by making the depth from 0.5 to 1 in., thus presenting the maximum surface practicable for a given volume of sewage recirculated over the reaeration surface. The desirable velocity of flow over this surface to prevent deposition of sludge was assumed to lie between 2 and 3 ft. per second, which corresponds closely with the range found by Streeter to be conducive of maximum values of the reaeration coefficient K_2. It has been determined that a slope of ½ in. per foot will give closely the desired velocity, even when transverse cleats are placed in the reaeration channel to induce riffling. As this slope is greatly in excess of the 2 ft. per mile, above which point the value of (c) increases most rapidly, the effect of such a slope is very favorable to increased values of K_2. Finally, as regards (n), in a channel of the type under consideration the hydraulic radius increases rapidly with increased depth, so that the velocity effect itself predominates, with a value of (n) close to unity; this is also true on account of the negligible effect of the depth (H). The conditions of flow, therefore, in a stream-flow plant are the counterpart of a natural stream progressing through a long series of riffles and pools, a condition known to be most favorable to self-purification within a minimum distance, measured in time.

Installation of Practical-Scale Stream-Flow Plant.—After the stream-flow idea had been given a thorough preliminary trial with the laboratory apparatus shown in Fig. 2, operating on milk wastes up to 2 per cent concentration and yielding results presented at a later point in this article, a practical-scale field plant was constructed at the Decker packing plant. Fig. 3 is a photograph of this installation, showing the general arrangement of the plant and types of pumping equipment employed for test purposes. Fig. 4 is a view of the second aeration unit (tank B indicated in the flow sheet of Fig. 5), taken to illustrate the realistic manner in which the recirculation of the sewage simulates the rills and riffles of a rapidly flowing shallow stream.

The structural features of a stream-flow plant, except for the aeration units, conform in essential particulars to the general design followed in the case of the activated sludge process. That is, a complete installation might comprise preliminary settling tanks, or screens, and final sludge settling tanks, together with appurtenances, in addition to the stream-flow aeration units themselves. As there is nothing in the aeration units to become clogged, whatever removal of suspended matter may be effected will be done to lessen the biochemical oxygen demand of the influent, or to recover such organic solids as may be utilized in the by-products department of the industrial plant producing the wastes. The provision of pretreatment by sedimentation thus becomes a matter of economics rather than one of necessity.

Effect of Recirculation on Retention Period.—In practice, circumstances will dictate as to the position of the inlets and outlets of the various tanks or basins and of the recirculation piping. Because of the removal and return of the sewage flow as it passes through each of the oxidation tanks or the various compartments of a single tank, it is evident that there will be an indeterminate amount of short-circuiting of the tank contents from inlet to outlet. The crude or average retention period is computed on the actual displacement basis, although in fact the aeration period of successive volumes of flow is variable.

The situation with reference to effects of short-circuiting may be regarded as analogous to that which prevails in regard to the flowing-through period in mechanically operated mixing tanks. This matter was thoroughly investigated in connection with the design of the coagulation tanks for the Sacramento, Calif., filtration plant under the direction of Charles G. Hyde, chief consulting engineer, and based on the original research work of W. F. Langelier. Professor Langelier concluded from experiments[4] that the probable under-treatment due to short-circuiting may be expressed by the formula

$$X = 1 - [1 - (1 - R/Q)^{t/n}]n$$

Where Q = capacity of each tank in gallons;
R = flow of water (gallons per minute);
n = number of tanks;
t = minutes actual retention in n tanks;
X = proportion of water remaining in tanks t minutes (or longer).

The formula is based on the assumption of practically instantaneous diffusion of incoming water with tank contents.

Curves based on the foregoing expression show that when there are two or more tanks, short-circuiting is greatly reduced, the number of tanks having a much greater effect than their capacity in obviating undertreatment due to short-circuiting. From actual operating experience at the plant mentioned, Jenks found that the proportion of total flow escaping adequate coagulation, or its retention equivalent, is negligible when three or more tanks are operated in series. It is concluded that similar results are to be expected from the aeration units of a stream-flow plant.

Pumping Equipment for Reaeration.—The manner of maintaining the auxiliary recirculation of the organic wastes through the reaeration system, as the main body of sewage progresses through the oxidation tank, is a matter to be decided upon the basis of convenience and cost. It will be recognized that the pumping problem here is

[4] Coagulation of Water with Alum by Prolonged Agitation. Eng. News-Record, vol. 86, No. 22, pp. 924-928 (1921).

a most unusual one, involving as it does the discharge of relatively large volumes of sewage against an extraordinarily low static head, amounting to perhaps not more than 4 to 6 inches. Of the standard forms of pumps, the screw pump offers one of the best means of meeting these operating conditions at a reasonable efficiency. Such a pump might, however, be unduly expensive when designed specially for an extremely low head. Accordingly, three special pumping mechanisms, such as might be fabricated in a local machine shop, were devised for the Decker experimental field plant. Tank A was provided with a plow pump; tank B with a propeller pump; and tank C with a plunger box pump. The general view of the plant, shown in Fig. 3, indicates these devices in operation. Their suitability for this service is being studied comparatively to determine which design might be used most advantageously.

Plant-Operating Data.—The operating results obtained from the stream-flow plant are based on an extensive series of tests, with the laboratory-sized plant (Fig. 2), on milk wastes, packing-house wastes, and sugar-beet wastes. The satisfactory treatment of these wastes from the standpoint of biochemical oxygen demand reduction, development and maintenance of an excellent activated sludge, and elimination of acid-producing constituents, led to the design and construction of a practical-scale field plant at the Decker packing plant. This installation enables a study to be made of the mechanical, hydraulic, and general engineering features of the new design.

Aeration Efficiency.—The efficiency of the stream-flow principle of aeration has been shown to be consistently as good as that of diffused air when treating the industrial wastes already mentioned. Illustrative of the results obtained on packing-house wastes (Decker), Table 1 is presented, which shows the reduction in biochemical oxygen demand after various aeration periods. The data are based on six weeks' operation, and the results are listed in the order of their occurrence. It will be noted that although the wastes being treated may be considered a 12-aeration-hour sewage, yet a remarkable reduction in b.o.d. occurs after only 6 hours' aeration.

As to comparative efficiency of stream-flow aeration, it is believed that the continual exposure of the sewage to the atmosphere, as it flows over the reaeration surfaces in thin films, more closely approaches the optimum conditions for oxygen absorption than any design heretofore proposed.

Effect of Biologic Staging.—The division of the treatment process into two or more stages, developing and maintaining a distinctly separate activated sludge for each stage, was conceived as a means of favoring increased biologic efficiency on the basis of the considerations relating to biologic zoning of trickling filters, as discussed at the beginning of this article. That this reasoning is essentially correct is evidenced in part by the results of stage treatment given in Table II showing that nitrification was secured by this means when treating 2 per cent milk waste by stream-flow aeration units. It may be noted that whether a primary stage of 6 hours was succeeded by a secondary stage of 18 hours, or the process reversed, nitrification for this type of waste ensued. In contrast with these results, Levine showed in previous research on the treatment of milk wastes that even with an unlimited supply of diffused air it was impossible to produce nitrates in single-stage treatment by the activated sludge process.[5]

Although the writers are aware that some engineers may be of the opinion that stage treatment does not commend itself on economic grounds for domestic sewage, yet they are convinced that biologic stage treatment merits serious consideration as an important aid in enhancing the efficiency of the activated sludge process where the more concentrated industrial wastes are concerned. This conception of the logical and proper method of operating an activated sludge plant is being given further study in the field stream-flow plant at Mason City. It appears that at least one important point that has heretofore not been adequately emphasized is the great advantage of removing as quickly as possible, from the aeration tanks, all excess sludge with its own high oxygen demanding characteristics gained by absorption from the wastes being treated. This can be accomplished by intermediate settling between stages, and so lessen the oxygen demand of succeeding stages. To take advantage of this fact, the Decker practical-scale stream-flow plant provides stage treatment in accordance with the flow sheet shown in Fig. 5.

Table I.—Reduction in Biochemical Oxygen Demand Effected by Laboratory Stream-Flow Aeration Unit, on Packing-House Wastes

(Based on plant operation during period July 14-Aug. 27, 1927)

Biochemical oxygen demand p.p.m., raw wastes[1]	Biochemical oxygen demand p.p.m.,[2] after indicated aeration period, in hours 6	12	18	22
1,000	300	65	60	120
1,180	....	115	95	90
700	80	40	40	50
1,100	43	18	20	28
820	56	33	33	30
925	44	25	26	26
600	32	98	70	45
650	38	30	30	59
550	52	13	34	....
1,225	40	74	79	73
1,300	48	33	27	47
1,050	106	110	28	....
2,000	132	69	56	....
Median value, 1,000	50	40	34	55
Apparent Satisfaction of Initial Demand, Per Cent[3]	95	96	97	94

[1]Settling-tank effluent.
[2]5-day biochemical oxygen demand at 20° C.
[3]Demand after various aeration periods taken on supernatant liquid; actual percentage satisfaction of demand should take into account transfer of oxygen-demanding substances to the activated sludge.

Power Requirements for Stream-Flow Aeration.—It can be shown by computations based on the deoxygenation curve described in a previous section of this article, and corroborated substantially by experiments, that a packing-house waste such as that found at the Decker plant and referred to in Table I can be treated by the stream-flow method through 12 hours' aeration, involving the recirculation of approximately 125 times the volume of sewage flow. Similar methods of computation applied to the case of a domestic sewage containing some industrial wastes, resulting in a biochemical oxygen demand of 350 p.p.m., should be successfully treated through six-hour stream-flow aeration of 50 times the volume of flow. For the latter case, assuming conservatively a lift of 4 in. and an over-all pumping efficiency of 25 per cent water level to water level, the required energy for aeration should not exceed 12 hp. per m.g.d. treated.

It is realized that only actual operating experience with a full-sized installation can demonstrate the correctness of such a power estimate. Yet, the order of magnitude of the power required is such that a considerable factor of safety might be introduced without seriously detracting from the favorable comparison that can be drawn between the stream-flow plant and existing means of sewage aeration. In fact, if sufficient difference in elevation exists at the treatment-plant site, it is possible to design the plant in such a manner as to obviate a substantial part of the recirculation pumping through

[5]Iowa Engineering Experiment Station Bulletin No. 68, p. 27.

Table II.—Changes in Nitrogenous Constituents Obtained by Aerating 2 Per Cent Skim Milk

Constituent	Aeration by Diffused Air, May 15 to June 7, 1922[1] Raw waste	Stream-Flow Aeration: Effluent after 21 to 45 hours' aeration	Raw waste, May 31 to July 5, 1927	23-hour continuous aeration	6-hour primary 18-hour secondary	18-hour primary, 6-hour secondary	6-hour primary, 6-hour secondary
Org. N	102.5	9.08	72.6	19.7	7.55	10.65	11.25
NH_3	1.70	12.70	1.4	.35	13.12	12.08	1.75
NO_2	.05	.01	.044	.01	5.38	5.07	3.8
NO_3	1.38	.12	1.38	.50	2.39	2.03	2.6

[1]See Iowa Engineering Experiment Station Bulletin 68, p. 27.
Notes.—23-hour continuous aeration based on tests, May 31 to June 2, 1927.
6-hour primary followed by 18-hour secondary, June 5 to June 24, 1927.
18-hour primary followed by 6-hour secondary, June 5 to June 24, 1927.
6-hour primary followed by 6-hour secondary, June 28, to July 5, 1927.

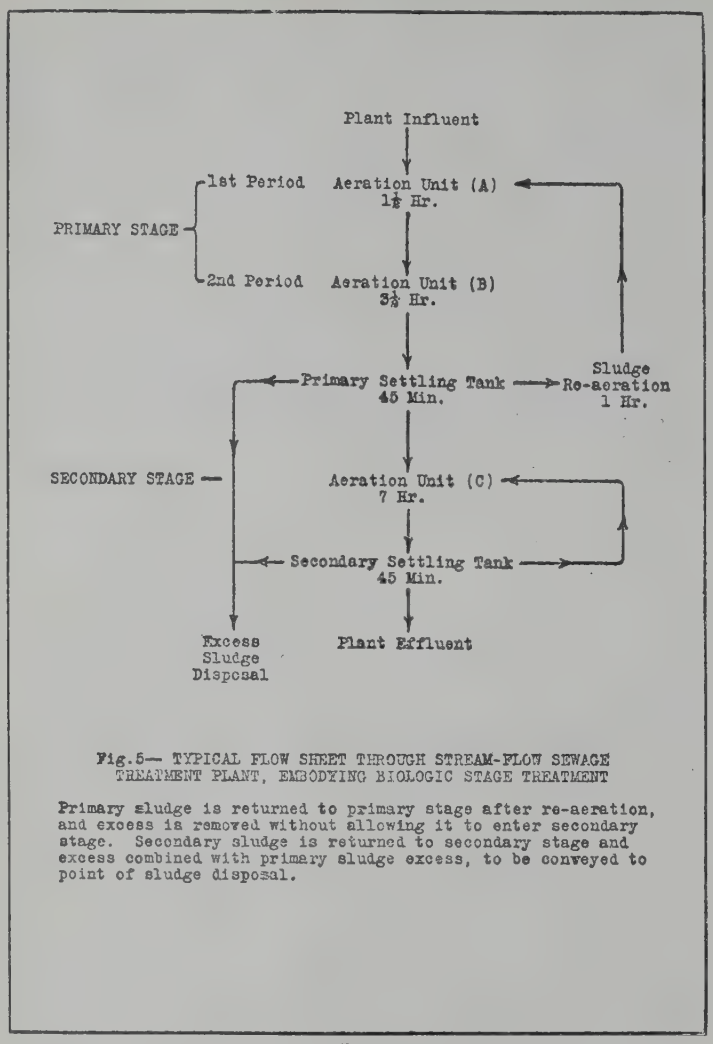

Fig.5— TYPICAL FLOW SHEET THROUGH STREAM-FLOW SEWAGE TREATMENT PLANT, EMBODYING BIOLOGIC STAGE TREATMENT

Primary sludge is returned to primary stage after re-aeration, and excess is removed without allowing it to enter secondary stage. Secondary sludge is returned to secondary stage and excess combined with primary sludge excess, to be conveyed to point of sludge disposal.

Fig. 5

the utilization of this available head. In such an event the conditions of aeration would closely approximate those found throughout the course of a natural stream bed.

Cost of Construction.—In the construction of a stream-flow plant it will be observed that it may be built so as to require relatively little excavation. In general, if excavation costs are high in comparison with the cost of area of land covered by the plant, then the tanks may be made quite shallow. For small plants it is suggested that the depth may be 4 to 6 ft. No dependence upon depth is required to provide a proper contact period of the air with the organic matter, which is a practical necessity in the diffused-air activated sludge aeration tank. The operation of the tanks entails the usual low loss of head resulting from flow through unbaffled basins at low velocities.

The stream-flow absorption of atmospheric oxygen insures an adequate oxygen supply without any expense for installation and operation of air piping and diffuser plates. Also, in comparison with air-washing and air-compressing equipment and machinery used in diffused-air plants, the extremely low-head pumping equipment and simple piping alone needed in the stream-flow plant is far less expensive, both in first cost and in operation.

It is suggested that for a plant to treat, say, 2 m.g.d., the first tanks might be provided with screw pumps discharging from 6,000 to 8,000 g.p.m. each. In the last tanks, where the recirculation rate is greatly reduced, plunger-box pumping units might be employed, operated by a common roller-bearing crank shaft, along each side of the tanks. In connection with studies of pumping requirements, an apparatus of unique design is being tested, by which advantage may be taken of the very low lift to utilize effectively the velocity head created by the pump impeller, operating on the vortex principle.

The reaeration surfaces may partly or wholly cover the aeration tanks or be laid as a pavement on natural ground along the edge of the structures. If the oxidation tanks are made of conventional depth, then the stream-flow aeration units will occupy very closely the same area as aeration tanks designed in the ordinary way. This is an important point which has been rightly emphasized by Streeter in discussing the relative economy of area required by various aeration devices typical of British sanitary engineering practice.[6] Experiments indicate that the reaeration surfaces should be from 6 to 10 ft. in length, providing three to five seconds' exposure of the sewage film to the atmosphere at 2 ft. per second velocity. A design factor will be determined empirically which will give the permissible recirculation rate in g.p.m. per square foot of reaeration surface. If required by severe weather conditions, the reaeration surfaces may be readily covered, air being admitted through suitably spaced ventilators.

It is not possible within the scope of this article to review the results obtained by other investigators in the field of sewage aeration by mechanical agitation, in order to point out the essential similarities and differences between stream-flow aeration and that secured by other means. It is the authors' hope that, after they and others who will become interested in this subject have fully overcome the difficulties that will naturally be encountered in the practical application of so novel a form of sewage-treatment plant, it will become a fitting engineering counterpart of the notable advances made by British engineers in the use of mechanical aeration in the activated sludge process.

It gives the authors pleasure to acknowledge at this time the very gratifying cooperation of the Jacob E. Decker & Sons organization, particularly on the part of Jay E. Decker, president, E. S. Selby, treasurer, and Elmer E. Dye, chemist of that company. Acknowledgment is also due all members of the engineering experiment station staff who have been interested in the furtherance of this project, among whom Harry E. Goresline, assistant bacteriologist, and George W. Burke, chemical engineer, have rendered valuable assistance in the laboratory work. Credit is also due Robley Winfrey, assistant director, for his helpfulness at all times in arranging the necessary financial and organization details of the project.

Acknowledgment.—The above article is taken from the Sept. 28 Public Health Report.

[6]Streeter, H. W., in Pub. Health Bull. 166, pp. 28-29.

Selecting Material for Earth Dam

Methods Employed for Granville Dam, Westfield, Mass.

By CHARLES TERZAGHI
Professor of Foundation Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

THE information obtained by exploring the proposed borrow-pit area on the left side of the dam was sufficient to show that by far the most suitable dam-construction material is located above elevation 560 (more or less) on top of the deposit of reddish sand.

By excavating additional test pits we learned that the composition of the deposit in the borrow-pit area is almost as variable as the composition of all the other deposits found in the vicinity of the dam site. Thus the question arose as to how we should determine during construction whether any newly-opened section of the borrow pit would furnish material with a sufficiently low average coefficient of permeability to permit its use. Since by necessity tests are restricted to samples selected at random, while the coefficient of permeability is apt to change from foot to foot, it seemed preferable to obtain approximate results for a great number of samples rather than accurate results for a few.

Method of Estimating Coefficient of Permeability.—To reduce the time and labor required for estimating the coefficient of permeabiliay of samples, we developed a method based on the fact that the speed of capillary rise of water through soil becomes less as the soil is less permeable. The theory of the process is somewhat complicated, because the speed of upward movement depends not merely on permeability but also on the ultimate height of the water level. Due to this complication there merely exists an approximate proportionality between the speed of capillary rise and the reciprocal value of the coefficient of permeability. A further complication is introduced by the fact that some air is retained within the voids of the soil while the water moves upward. Nevertheless, the fact remains that the steepness of the curve, which represents graphically the speed of capillary rise, increases with the permeability of the material. Figure 1 shows curves for those samples whose permeability was accurately determined. By observing the capillary upward movement for any sample and by plotting the results on Fig. 1, one can roughly estimate the coefficient of permeability of the material.

Testing Device and Procedure.—The device for making the tests is shown in Fig. 2. It consists of a simple tank (A) made of sheet tin, an irrigator for feeding the tank, and a set of glass tubes (G), made of hard glass. Hard glass is essential, otherwise the cylinders invariably break during the tests. The bottom of each glass tube is covered with a brass wire screen stretched across and soldered to a brass ring. In order to test a sample, the procedure is as follows:

The sample is dried on a stove, after which it is placed in one of the glass tubes, in layers 2 cm. thick, until the cylinder is completely filled. Each layer is compacted by lifting and dropping ten times from an elevation of 4 in. a cylindrical pestle made of hard wood, with a diameter of 1¼ in. and a weight of 150 grams. In case the sand grains are smaller than the openings of the sieve, a 2 or 3-mm. layer of coarse sand is placed on the sieve before the first layer of the sample is introduced. In the meantime the tank is filled with water supplied from the irrigator, the excess water passing over the crest of the overflow (W) and draining away through the discharge pipe. As soon as the cylinder is filled with the sample, the brass sieve is wetted with a mist cloth and the cylinder is placed on the immersed support (S), as shown in Fig. 2. Care should be taken to keep the cylinder in a slightly inclined position while lowering it through the surface of the water so as to offer a chance for lateral escape of air.

As soon as the base of the glass cylinder touches the surface of the water, the water starts to rise by capillary action within the sample, as indicated by the color of the sample turning dark. The smaller the permeability of the sample, the slower is the upward movement of moisture. Readings of the rise in water level are taken 5, 10, 20 and 30 minutes after the test is started. The simplicity of the necessary operations permits six tests to be carried on simultaneously.

Observation During Construction.—After the report on the soil studies was presented, the underground strata were exposed to direct inspection by the construction of the core trench and the excavation of the borrow pits. It was found that the underground conditions checked with the predictions. The right (southern) wing of the dam rests against a very feeble permeable portion of the south slope. The permeability of the material from the borrow pit averages, according to the results of the capillary tests, 0.000068 cm. per sec., which is below the value of 0.0001 cm. per sec., on which seepage computations were based. The layer of boulders, which covers the bottom of the valley is strictly confined to the area between the slopes. Although the material was found to be very compact, the core wall was constructed so as to prevent subterranean erosion along individual seams or channels. The bed rock was more badly shattered than was expected from the drilling records; as a consequence it had to be grouted.

In order to exclude borrow-pit material that is more permeable than we intended to tolerate, a curve (k) was traced on Fig. 1, corresponding to the capillarity curve of a material with a coefficient of permeability of 0.0001 cm. per sec., on which the estimate of seepage losses was based. From time to time, particularly in case a stratum of doubtful quality was encountered, samples were tested by means of the

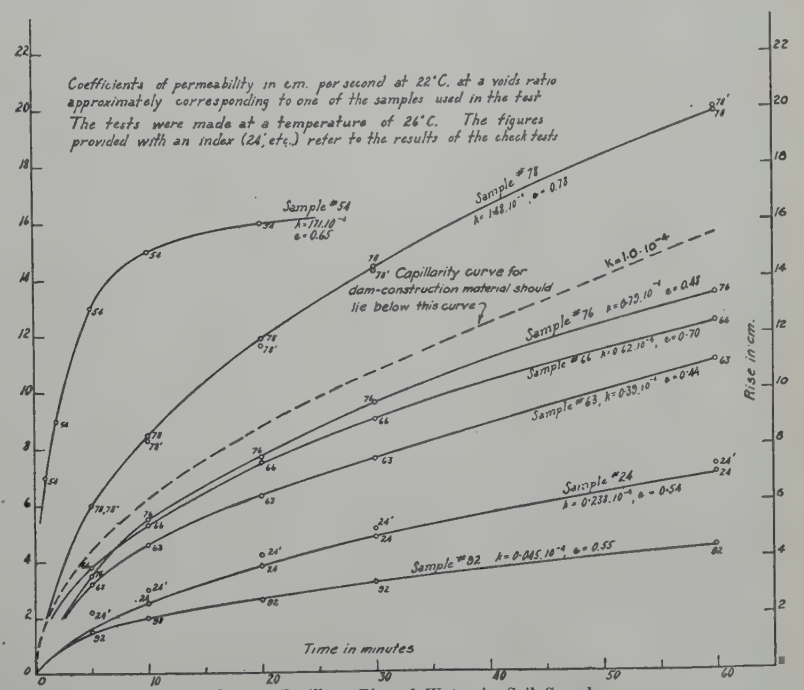
Coefficients of permeability in c.m. per second at 22°C. at a voids ratio approximately corresponding to one of the samples used in the test. The tests were made at a temperature of 26°C. The figures provided with an index (24', etc.) refer to the results of the check tests
Sample #54 k=711.10⁻⁴ e=0.65
Sample #78 k=148.10⁻⁴ e=0.78
Capillarity curve for dam-construction material should lie below this curve?
k=1.0·10⁻⁴
Sample #76 k=672.10⁻⁴ e=0.68
Sample #66 k=0.42.10⁻⁴, e=0.70
Sample #63, k=0.30.10⁻⁴ e=0.64
Sample #24 k=0.238.10⁻⁴, e=0.54
Sample #82 k=0.045.10⁻⁴ e=0.55
Time in minutes
Rise in cm.

Fig. 1—Capillary Rise of Water in Soil Samples

apparatus shown in Fig. 2, with the intention of excluding from use in the dam any material whose capillarity curve is located above curve (k). The material in which the steam shovel worked, was more or less stratified, but when it broke off the bank and was picked up by the shovel, it became well mixed so that the samples taken from the trucks were fairly representative.

Testing Embankment Material.—During construction, two questions arose concerning methods for testing embankment material: First of all, whether or not the drying of the material in the stove has any influence on the results of capillarity tests and second, whether the volume of voids of the material in the embankment is smaller or greater than the volume of voids obtained when compacting the material in the standpipe of the capillarity apparatus. Due to the great influence of the volume of voids on permeability, the second question was of vital importance.

Concerning the first question, we found that the drying process had no appreciable effect on permeability, inasmuch as the tests with air-dried and with stove-dried sample gave practically identical results. In order to answer the second question, undisturbed samples were secured from a pit excavated in the finished embankment. Excavation of the pit was difficult and required the use of pick and shovel, which demonstrates the excellent results obtained by compacting with Caterpillar tractors. Due to the presence of many stones in the fill, a cylindrical sampler with cutting edge could not be used. Hence, large chunks of soil (up to ¼ cu. ft.) were removed and sealed on the ground by repeatedly painting their

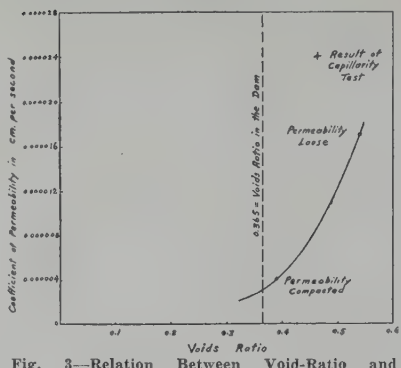
+ Result of Capillarity Test
Permeability Loose
Permeability Computed
0.365 = Void Ratio in the Dam
Coefficient of Permeability in Cm. per second
Voids Ratio

Fig. 3—Relation Between Void-Ratio and Permability of Loose and Compacted Soil

surfaces with hot paraffin. In the laboratory the volume of the sealed chunks was determined by immersing them in water. Afterwards the chunks were skinned and the original and dry weight of the chunks and the specific gravity of the solid constituents were determined. From these data was computed the volume of voids of the more fine-grained mass that filled the interstices between the stones. This volume of voids was found to be equal to 26 per cent of the total volume. Finally, the more fine-grained material was transferred into a permeameter, and the permeability was determined in a loose and in a compacted state. At this time we learned that it was practically impossible to bring the density of the material in the permeameter, by ramming it in a moist condition, up to the density of the material in the embankment. Figure 3 shows the test results. These indicate that permeability decreases with decreasing voids-ratio much more rapidly than one would expect. This was due to the appreciable mica-content of the sample. From previous experience we know that the finer the soil and the greater the percentage of scale-like particles, the steeper is the voids-ratio-permeability curve. Figure 3 also shows that the voids-ratio of the sample compacted in the standpipe of the capillarity apparatus is considerably greater than the voids-ratio of the material in the embankment (0.464 against 0.366). Hence, the factor of safety against excessive percolation is ample when computations are based on the results of capillarity tests.

The method of keeping track of the quality of the dam-construction material by means of capillarity tests was found to be satisfactory except in so far as the relation between permeability and the speed of capillary rise depends to a certain extent on the character of the sand grains and silt fraction. For this reason two materials with equal permeability are apt to have two somewhat different capillary-rise curves, and a set of curves similar to those in Fig. 1 cannot be depended upon except for the same class of materials. In order to eliminate this shortcoming, modifications of the testing procedure are under consideration.

Acknowledgment.—The above is an extract from a paper in the June issue of the Journal of the New England Water Works Association.

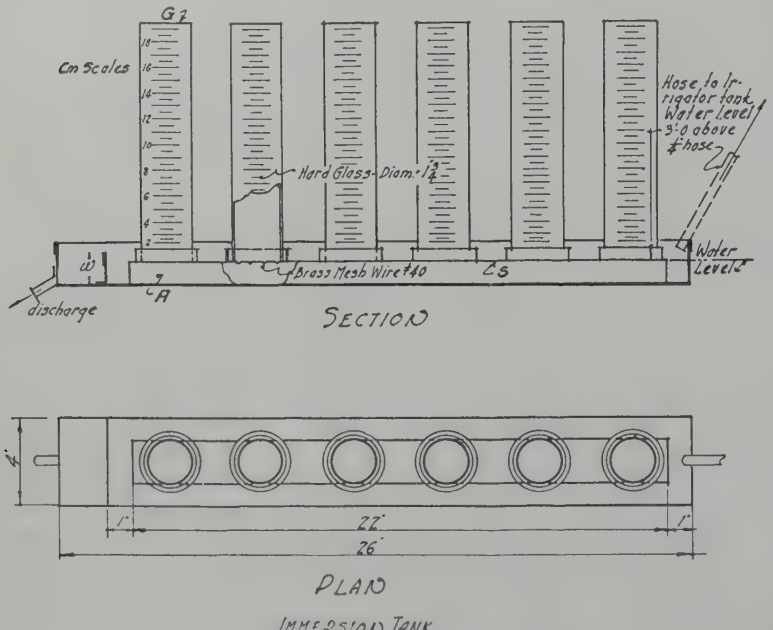

Fig. 2—Device for Observing Capillary Rise of Water in Soil

Serious Water Famine in England

Press dispatches from London, under date of July 17, state that England is suffering from a very serious water famine due to lack of rainfall. Official appeals for the most rigid economy have been made nearly everywhere in the largest cities and in the smallest villages. The situation is critical for households and industries.

So serious have matters become in the woolen mill district of Yorkshire that general restrictions have been introduced. On the above date Dewsbury had only a twelve hours' a day service and thirty-one days' supply, while the neighboring town of Batley had only fifteen.

Conditions are serious in the villages surrounding Oxford. In the Crown Marsh rural area water must be carried in barrels half a mile. At St. Eventon in Berkshire there is a supply only on alternate days, while at Milton the supply has been cut off between 1 in the afternoon and 8 in the morning.

Unless rain falls soon, Boston will be faced with a repetition of the 1921 water famine, when supplies had to be brought from Willoughby by rail. The brook at Miningsby, Boston's regular source of supply, dried up three years ago, leaving the town dependent on the waterworks company's single reservoir.

Throughout the country warning notices have been posted and handbills have been distributed requesting the public to be careful in the use of water and to refrain from watering gardens and washing automobiles.

Recent Developments in Water Works Field

Abstracts of Papers Presented at Toronto Convention of American W. W. Assn.

Manganese Dioxide Deposits in Catskill Aqueduct

The Cause and the Proposed Remedy

By FRANK E. HALE
Director of Laboratories, Bureau of Water Supply, New York City

THE Catskill aqueduct from Ashokan reservoir to Kensico reservoir was first put into service late in 1915 to serve a portion of the Bronx. Early in 1917 the full available quantity of water from Esopus Creek was brought down to supply portions of all boroughs of New York City. Chlorination at Ashokan headworks was placed in regular operation January 10, 1925. On December 11, 1924, the flow of water in the aqueduct was increased to maximum capacity, approximately, due to the fact that a portion of the Schoharie development became available. In the aqueduct there is visible evidence of the average flow of water at two levels representing about 400 m.g.d. and 600 m.g.d.

1 In. Deposit Formed.—It was noted that a brown deposit formed on the walls of the aqueduct up to the original water level and that this deposit exercised considerable influence upon the amount of water flowing through the aqueduct. The deposit reached as much as 1 in. in thickness near Ashokan reservoir, prior to chlorination.

The increased flow in the aqueduct and chlorination were introduced at about the same time. Following chlorination the deposit reduced in thickness, became detached in large areas, and less effect was noted on the available capacity of the aqueduct. The matter seemed of sufficient importance to ascertain the character of the deposit, its distribution, the extent and reason for the influence of the chlorination, with a view to ascertaining whether the introduction of additional chlorination at intervals and at points further down the aqueduct would be feasible and desirable for the purpose of increasing the available capacity of the aqueduct.

Consequently the aqueduct was emptied and inspected on Oct. 8, 1928, between Ashokan and Kensico reservoirs at numerous points and samples of the deposit taken for examaintion.

The coating consists of a soft, very dark brown substance (chocolate color), with the exposed surface of a polished or greasy appearance, much like dark wet mud. This can be readily scraped off, being only loosely attached, and patches had been removed by the flowing water and large portions had slipped down near the bottom. Where the entire area in contact with the water was found coated, the surface was uneven, similar to a "spatter-dash" finish obtained with thin mortar. The surface of new coating resembled a "stippled" finish.

The surface of the concrete beneath the coating had a rough sand finish, due to solution of cement at the surface.

Chlorination Reduced Thickness of Deposit.—The effect if the chlorine had been to reduce the thickness of the deposit, possibly hasten its detachment in areas, and prevent new deposit on fresh cement surface thus uncovered. It was also noticeable that between the old and new water levels no deposit had taken place. This effect of the chlorine reached many miles down the aqueduct since the first new deposit was noted at Newburgh, 37 miles from Ashokan reservoir, and the old coating patches were thicker (¼ in.) than at the point above (⅛ in.) 24 miles. At 48 miles and below, across the Hudson, the entire surface was again coated.

The seven samples were examined microscopically both with and without treatment with dilute hydrochloric acid and there was absolutely no indication of any microscopic plant growth nor organic structure.

All of the above samples were dried in oven at 105 deg. C. The loss on ignition was then determined on these dried samples, measuring water of hydration. During this ignition there was absolutely no odor or organic matter nor any evidence of black char. This would indicate that the deposit was entirely of mineral character.

Qualitative tests of the deposit for the presence of manganese dioxide showed it to be abundantly present. For example, treatment with hydrochloric acid (1:1) produced sufficient chlorine gas to be strongly visible and odorous and heating produced a strong evolution of green chlorine gas, leaving the residue pale pink.

Analysis of Samples.—As there was every indication that the deposits were more or less alike, only samples Nos. 1, 4, 5 and 7 were given detailed analysis, Nos. 1, 4 and 7 being representative of the nearest point to Ashokan, an intermediate point, and the furthest point sampled. No. 5 represented the new growth. In taking these samples it was noticeable that the cement surface had been dissolved by the water, leaving a rough surface of small sand grains. These were obvious also in the samples examined. Under the heading of "Sand and cement from the walls" has been included the insoluble in hydrochloric acid and the soluble silica, lime and magnesia. The last three were very small in amount, ranging from 1½ per cent to 3½ per cent of the total dried weight of deposit. The constituents of the brown deposit have been calculated on a basis of absence of sand and cement from the walls.

The chemical analyses of these samples are as follows (Table I.):

The amount of sand and cement varies inversely with the thickness of the brown deposit due to variation in amount of scraping of the walls in obtaining samples. The deposit from which No. 5 was taken was very thin hence contained much more sand.

Manganese Present in Supply.—It is obvious that the largest constituent of this deposit is manganese dioxide. Determination for manganese in the Catskill water as it leaves Ashokan reservoir showed it to be present at this time to the extent of .04 ppm. It is also present in the Croton supply to the extent of .08 ppm. which is sufficient to cause deposit of manganese dioxide in the bottom of Croton Lake, which is disturbed by the fall over-rising to such an extent that visible brown floc of manganese dioxide is present in the Croton aqueduct water in the fall of the year. This manganese dioxide explains the orthotolidin reaction appear-

Table I

Samples	No. 1 Per Cent	No. 4 Per Cent	No. 5 Per Cent	No. 7 Per Cent
Sand and cement from the walls	35.64	39.98	56.82	37.01
Brown deposit	64.36	60.02	43.18	62.99

Table II—Analysis of Brown Deposit
(Calculated on basis of absence of sand and cement)

Samples	No. 1 Per Cent	No. 4 Per Cent	No. 5 Per Cent	No. 7 Per Cent
Loss on ignition (H_2O)*	25.64	30.25	29.41	27.52
Manganese dioxide (MnO_2)	46.64	41.51	33.09	41.13
Iron oxide (Fe_2O_3)	20.51	24.07	31.73	19.12
Alumina (Al_2O_3)	7.21	4.17	5.77	12.23
	100.00	100.00	100.00	100.00

* No char nor organic odor.

ing before chlorine is added and which regularly increases every fall dropping to almost nothing in winter. Judging from the phenomena observed with the Croton water the small amount of manganese in the Catskill water is probably the source of the manganese deposit on the wall of the Catskill aqueduct.

In the Journal of the American Water Works Association, volume 18, July, 1927, page 1, was described the work of C. A. H. Von Wolzogen Kuhr on Manganese in Water Works in Holland. It is there stated that the deposit of manganese dioxide takes place through the action of certain bacteria and certain mold growths and a special medium is described by which these bacteria were isolated after several months growth. They were obtained from both the water and the brown deposit. This special medium was made up at Mt. Prospect Laboratory and streaked with Catskill water and also from the brown muck. In many tests and after many weeks there was no evidence of any bacterial growth along these streaks causing a brown deposit of manganese dioxide. Certain molds which undoubtedly fell into the plates from the air during examination caused a brown deposit.

Cause of the Deposit.—It is our opinion that the manganese dioxide has been deposited from the water by the effect of absorption of alkali from the cement producing an alkaline reaction adjacent to the wall. This alkaline reaction is necessary for the reaction to take place and the inspection and analyses showed that the cement had disssolved from the surface of the concrete. Iron trioxide and alumina may have similarly been deposited from the water or their source may have been the cement.

It was at first thought that the deposit might be due to bacterial action, inasmuch as it was 1 in. thick prior to chlorination in the aqueduct near Ashokan and covered the entire area of wall exposed, whereas at the time of this inspection the deposit at the first point was in patches and only ½ in. thick and no new growth was noted until sampling point No. 4 was reached. Since there is no evidence of bacterial action and hence sterilizing effect of the chlorine, a possible assumption is that prior to chlorination the alkalinity produced by solution of cement from the surface was greater than at present, thereby producing a stronger alkaline reaction. Also that since chlorination the residual chlorine tends to neutralize any alkalinity produced in the upper portion of the aqueduct and that this action is lost below Newburgh.

The question of addition of chlorine at Newburgh to reduce the deposit below this point and possibly increase the flow of the aqueduct by 30 m.g.d. is still under consideration.

Innovations in Water Treatment

How Some Ontario Problems Were Solved

By A. V. DELAPORTE
Chemist in Charge, Experimental Station, Ontario Department of Health

THE removal of turbidity and bacteria has become so standardized, as to require no comment. Taste and color removal without excessive chemical treatment, give an opportunity for novel application of standard methods.

Taste is an elusive thing, and is in part a psychological problem. The delicacy of the perception of taste varies with each individual, and as the flavors of some surface supplies vary with the season, and the temperatures, the investigator is sometimes at a loss to correlate the data which he has collected.

Removal of Phenolic Taste.—The removal of phenolic taste from the Toronto water supply by super-chlorination and dechlorination, is, in the writer's opinion, the greatest innovation in recent years, of water treatment in Ontario. This accomplishment is due principally to Norman J. Howard. The process and results have been fully described by Mr. Howard in the technical press.

In the sanitary engineering division of the Ontario Department of Health, we have approached the same problem in a different manner. We had first to secure a yardstick for the measurement of phenols. We tried several different methods including the Folin & Dennis method, and the Gibbs method. At present we are using the Fox & Guage method with fair results. This method has one major trouble. The indicator is a diazo compound composed of sulphilanic acid and sodium nitrate. This decomposes readily, and must be kept on ice.

The next point of attack on the problem was the source of the taste-producing substance. We found that fresh domestic sewage carried phenol in appreciable quantities. (2) That the phenolic content of sewage increased with storage, phenol being one of the degeneration compounds of the proteins under anaerobic conditions. (3) That phenols were present in wastes from certain industries using coal or its by-products. (4) Water that had been in contact with certain grades of coal tar or oil, carried phenol. (5) That certain wastes from rubber industries carried substances that gave phenol reaction.

Having located a number of possible sources of phenolic pollution, the problem is the prevention of this pollution, and the elimination of the phenol from the water where prevention could not be undertaken.

Here, the advance has not been great. We have proved that phenols are readily oxidized by atomic oxygen. In the activated sludge process—by potasium permanganate, and by chlorination, or in the passage through a properly functioning slow sand filter. To date we have found no practical means of removing phenol by precipitation, absorption, or mechanical filtration, Organic tastes, which after phenol, cause most complaint, are really from three different sources. They are (1) from plankton, (2) from decomposing plankton, (3) from other decomposing organic matter. Some years ago, the writer reported treating the water supply at Richmond Hill with compressed air. It was very evident that a large portion of the taste-producing substances were either gaseous, or of a volatile nature. Continuing our observations at this plant, we found that fairly violent aeration in the mixing chamber caused a foaming. The air passing from the water had a strong marshy smell. The foam, which rose as high as 5 ft., on collection and settling was very similar to a septic effluent in appearance and odor. Chlorine in excess was tried instead of aeration, and gave good results, but not as good as the air had given; but a combination of the two gave really remarkable results.

The water supply of Burks Falls is very interesting. It has color, turbidity, taste, and is slightly acid. The supply is a gravity flow from Reazin Lake through mechanical pressure filters. Reazin Lake, the source of supply, lies in the wilderness about four miles from the town. The filtration plant is about one-half mile out of the town. All chemicals used in the treatment must be introduced under pressure. It was found that pumping a slightly alkaline solution of sodium hypochlorite into the main before filtration, accomplished complete removal of color, taste, turbidity, and acidity. The chlorine oxidized the iron and sulphides, which caused the color and taste. The precipitated iron acted as coagulant on the filters. A clear, colorless, tasteless effluent was obtained.

Color Removal at Dundas.—At Dundas, the problem was color removal without an excessive dose of alum. In order to remove the color successfully using alum only, sufficient alum was required to lower the pH value to the iso-electric point. Acid was used to lower the pH value with minimum dosage of alum without success. Aeration was tried, first in the settling tank, and then in the mixing chamber. The system was arranged after the manner of an activated sludge plant. The floc, as it settled out, was returned to the incoming water, with really excellent results. There were mechanical difficulties in the return of the sludge, which militated against complete success; however, in the remodelling and enlargement of this plant, aeration will be incorporated as a permanent fea-

ture, and the pre-treatment of the water will virtually consist of an activated sludge process.

North York has a periodic disturbance in the taste when there is a heavy run-off from the agricultural land draining into the source of supply. A strong strawlike taste develops. We have controlled this by maintaining a fairly high residual chlorine, and by the use of ferric chloride.

Smith's Falls secure their water from the Rideau Canal. Above the intake, there is a large area of drowned lands which had not been cleared before flooding. This area is a hotbed for the growth of equatic flora and fauna. The result is that the raw water for the town is an aquatic zoo. This summer, the plan is to control the taste temporarily with ferric chloride, and to experiment with aeration in an endeavor to reduce the chemical dosage.

The last experiment was carried out at Brampton last year. Brampton has an auxiliary supply from Snell's Lake. This water, highly charged with micro organisms, is filtered through Ransome drifting sand filters, and chlorinated. Last July, the odor from the filters in the pumphouse became very bad, and there were serious complaints as to taste. Pre-chlorination was resorted to as a temporary expedient. The odors were eliminated, and to a certain extent, the taste also. Even with a dose of 60 p.p.m. of chlorine for three days, we had no residual chlorine after filtration.

Bacteria on Leather Washers

Lactose-Fermenting Organisms Growing on Leather Washers at Chicago

By F. E. GREER and L. C. KELLS
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IN recent years water samples from various hand sampling pumps used to draw waters from the tunnels of the Chicago water supply system have shown unexpectedly high Bact. coli-aerogenes indices which were not explainable on sanitary survey and were not consistent with the current findings of raw Lake Michigan water or with water from other sampling pumps on the same tunnels. The first such instance of persistently high coli-aerogenes indices in a sampling pump occurred at the Lake View station and led to the discovery of an old abandoned sewer near the sampling point on the tunnel. However, after elimination of this possible source of contamination, the high coli-aerogenes findings still continued.

Investigation of Washers.—At a conference of Arthur E. Gorman and H. H. Gerstein of the water control division, with Dr. Fred O. Tonney and the writer representing the research laboratories, it was decided to investigate the washers along the lines reported by Sir Arthur C. Houston in connection with a similar problem arising in the London water works system. The washer was removed by Mr. Gerstein and brought to the laboratory, where it was placed in a mason jar containing 300 c.c. of sterile tap water and kept at room temperature. Examination of the water showed the presence of Bact. aerogenes in large numbers. In the course of a few weeks, the number of organisms had increased to 3,000,000 per c.c. At this point the water in the jar was drawn off and replaced by another 300 c.c. of sterile tap water. An initial drop in the count was again followed by an increase in numbers which soon reached millions per c.c. Repeated changes of water gave the same findings and the washer retained its ability to support growth of Bact. aerogenes for the two years it was under observation in the laboratory.

Following this experience, other investigations led to the discovery under similar circumstances of three examples of washer contamination with organisms of the coli-aerogenes group in the city water supply system. Replacement with new leather washers was in some instances followed by reinfection after a time and recurrence of the same condition. Of the four organisms found growing in the sampling pump washers, one was identified as Bact. coli, one as Bact. aerogenes, and two were classified as members of the coli-aerogenes group by the Standard Methods procedure.

Two leather washers collected from fire hydrants were also found to contain large numbers of coli-aerogenes organisms. Placed in sterile tap water, they developed increasing numbers, one reaching the total of 40,000,000 per c.c. This organism proved to be a typical strain of Bact. coli.

Four other washers from private wells in which high coli-aerogenes findings were not supported by the evidence of the sanitary survey, were found to contain lactose-fermenting organisms of the coli-aerogenes group and to support their continued growth in large numbers for a long period. In all four cases, removal of the infected washers from the pumps was followed by the disappearance of the coli-aerogenes organisms from the well water.

Brass Cylinder Pumps Substituted.—On the basis of this investigation, H. H. Gerstein of the water control division, recommended that all pumps containing leather washers be replaced by brass cylinder pumps. As soon as this was done, the abnormally high indices stopped. There was one exception to this, however, at the Springfield Avenue sampling point. Upon investigation it was discovered that a leak had developed in the new pump and that the engineer had repaired the leak with packing. When the packing was removed the Bact. coli disappeared. In the laboratory this packing yielded many thousands of Bact. coli even after repeated washings.

While these investigations were under way we became interested in the possibility of growing the various lactose-fermenting organisms found in water by experimental inoculation on leather washers.

For this purpose four new leather washers were soaked in alcohol for some time and alcohol gradually diluted with sterile tap water over a period of several days. Sterility tests made on the washers after one week showed no organisms that would grow aerobically or anaerobically on agar plates or in lactose broth.

Experimental Inoculation of Leathers.—Two of the washers were then inoculated with pure strains of Bact. coli and two with pure strains of Bact. aerogenes. The initial inoculum was about 1,000 organisms per washer. The organisms immediately began to increase in number and in a period of two weeks the washers containing Bact. coli showed 6,000,000 and 4,000,000 Bact. coli per c.c. while the washers containing Bact. aerogenes each showed 300,000,000 per c.c.

All of the washers, both those from the pumps and those experimentally inoculated, supported continual growth of the organisms in the jars despite the frequent washings and changes of water.

Another set of washers was inoculated with Bact. typhosus, Bact. aerosporus, Cl. welchii and Strep. fecalis. The tests were carried out as before. There was no increase in the number of these organisms on any of the washers. In the course of a few weeks it was not possible to recover any of the organisms from the water containing the leather washers; moveover, there was no over-growth by other organisms.

The washers which had been inoculated with strains of Bact. typhosus, Strep. fecalis, Bact. aerosporus and Cl. welchii were then immersed in alcohol and the alcohol gradually diluted with water over a period of several days. After they had been found sterile, the washers were inoculated with strains of Bact. aerogenes and Bact. coli isolated from sewage. All the organisms grew luxuriantly, notwithstanding frequent washings and changes of water.

A canvas washer impregnated with paraffin was inoculated with a strain of Bact. cloacae and studied under the same conditions as the leather washers. Bact. cloacae continued to grow for several months. After this time the washer was sterilized and then inoculated with a pure culture of Bact. aerogenes. This organism also multiplied at a rapid rate, notwithstanding frequent washings and additions of sterile water.

At the suggestion of W. F. Langelier of Leland Stanford University in a

letter to Dr. Tonney, reporting a slimy growth which he encountered in well water, we decided to include Bact. mucosus capsulatus in the series. A strain of this organism was therefore inoculated into washers. We obtained a typical slimy growth and the organism increased in numbers on leather washers over a considerable period of time. The possibility of growing coli-aerogenes organisms on leather washers in a continuous stream of water was next tried. The washers containing the organisms were placed in running tap water under conditions of continuous rapid flow, continuous slow flow and intermittent flow. On some of the tests the washers were dried and again tested as in the preceding experiments. In every case the organisms grew readily on the washers in the presence of flowing water. The growing of these organisms in mixtures on leather washers was next investigated. Bact. coli with Bact. mucosus capsulatus and Bact. coli with Bact. aerogenes were tested. All of these organisms grew readily in mixtures on the leather washers. Finally a new sterilized washer was immersed in treated sewage, containing approximately 100 Bact. coli and 50 Bact. aerogenes per c.c. and tested in the manner described. In all these tests the organisms grew and increased in numbers on the leather.

Stream Pollution

Pure Stream Movement Will Accomplish Its Purpose

By SCOTLAND G. HIGHLAND
Secretary and General Manager Clarksburg Water Board, Clarksburg, W. Va.

THE question of pollution of drinking water supply sources is of paramount importance, and we must go into the matter impervious to the pleas of commercialism, and with the determination, should persuasion fail, to carry it by petition to our respective legislatures.

With an increasing population has come an increasing need for good drinking water, and a decreasing available supply; rapidly growing towns and cities spill their filth into sewers that empty into the nearest water channel, while our multiplying industries seek the least expensive method of disposing of their waste. In this matter of steam pollution, however, those directly responsible for it, and we who supinely tolerate it are equally to blame for the crime.

Lack of Vision Basic Cause.—It is astonishing that there should be any opposition to the preservation of clean streams, yet the opposition is strenuous, founded partly on lack of vision, but mostly based upon selfish motives. A misleading argument of the opposition is that the pure stream movement is backed by sportsmen, and that it is an impractical dream; that the people are confronted by a choice between fish and industry. This contention is absurd, for not only fishermen, but all intelligent persons recognize the fact that the water of streams in which fish cannot live is unfit for human beings to drink, and that the preservation of human life is necessary for the continuance of industry.

Defilement of Streams Indictable Offense.—There is a great deal of ignorance among industrial heads about the legal status of stream pollution. There seems to exist a prevailing impression that the pollution of lakes and rivers is a perfectly natural, and even lawful custom in the absence of specific statutes prohibiting it. The contrary is true. Polluters, great or small, are law breakers. Many highly respectable offenders do not know that from the early days of common law, the defilement of streams has been an indictable offense when such defilement affects the public, and the right to restrain by injunction any one who corrupts water with industrial waste is a very ancient right.

Education is the Solution.—A better remedy, however, lies in the arousing and educating of our people to the gravity of the situation, and a special effort should be made to induce manufacturers and those connected with polluting industries, to give their personal thought and time to the investigation of present conditions. They are keen, level-headed men, and they do not take delight in poisoning the water needed by the people; in this age of terrific efficiency they have sought to keep down the expenses of operation by getting rid of the waste in the most convenient manner, with little if any thought about the result.

In years gone by, there was little complaint; our streams were numerous and full of water, our industries comparatively few, our population small, and under those conditions the water, most universal of solvents, could digest or carry away impurities. Our streams can no longer do this, and if the industries do not realize this fact it is certainly time that they were told it.

Many of those who are engaged in industries that pollute water are citizens of the finest type, as proud of their community, state and country, as the rest of us, but much missionary work must be done among them, where one convert will count as many missionaries.

Industrial Chemists Problem.—Practically every business involves problems that must be solved in office or laboratory. It is not the duty of the water utilities nor of the state to conduct experiments for the solving of the waste disposal problem for the hundreds of industries within its bounds. The cost of maintaining a corps of skilled chemists would be prohibitive, but every plant, or particular industry is forced to employ the best engineers and chemists in its special field. These experts are best fitted to deal with and solve this problem, and a definite co-operation of one with all, would reduce the cost of experimentation to a minimum sum, which, when apportioned would not bear too heavily upon any one of the numerous enterprises affected. It is but just that the expense of experimenting should be borne by those who are making money in the offending industries.

Using Water Courses as Sewers.—The only duty devolving upon the state is that of telling big and little business, individuals, communities, hamlets, villages, towns and cities that they can no longer use the streams as sewers, and that they must take prompt action in otherwise disposing of their waste product. Experience thus far shows that, unless forced by law or a supervising state agency, industries will not change their present life-destroying methods, but although the task of converting the manufacturers and other polluting groups may be difficult, compensation is to be found in the rapid progress now being made in educating the rest of the community to vigorous and incessant protest that will result in legislative action in the matter.

Accept the Inevitable.—The pure stream movement is based upon the primal law of "the inalienable rights of the people"; it will accomplish its purpose, and unless the polluters accept the inevitable, take the initiative and show the people a commendable willingness to clean house, an indignant public may demand legislation of so drastic a nature that real industrial harm would ensue.

Far Afield for Drinking Water.—Many cities have had to go far afield for their supplies, as the capacity of wells, adjacent stream or lake, became inadequate to meet the demands of the community, but very often it was the pollution of the local supply that made necessary the seeking of more distant sources.

Far Afield for Drinking Water.—Conspicuous examples of such cities are: Los Angeles, which brought her new supply from 235 miles away; San Francisco, 154 miles; New York, 120 miles; Tulsa, Oklahoma, 60 miles; Phoenix, Arizona, 32 miles; Butte, Montana, 27 miles; Denver, 25 miles, and Norfolk and Portsmouth, Virginia, about 20 miles each.

Winnipeg, Canada, brought her new supply a total distance of 98 miles, while Victoria went 38 miles for water.

In Australia the Coolgardie pipe line is 351 miles in length, and in southern Italy, the Apulian Aqueduct, constructed in 1924, to supply 266 communities, comprises 152 miles of main conduit, and 841 miles of main and subsidiary branches leading therefrom.

Self-Preservation the Issue.—In view of the enormous expense incurred by carrying water such distances, an expense which the people at large must bear, it seems incredible that they have ever tolerated the corruption of nearer

supplies of something essential to the preservation of their lives.

Experience is not only a hard, but a very costly teacher, but the growing agitation over the pure stream question, will be the means of protecting the fledgling cities of today, and those of future years from the gross wrongs inflicted on us by the pollution of drinking water supplies.

Water Borne Treponema Pallidum.—Investigations carried on behind the battle lines in Europe have modified, to a considerable degree, the opinion prevailing among physicians and sanitarians that no danger existed from the bodily discharges of persons infected with the deadly germ treponema pallidum. The danger is now quite generally recognized, and the fact that these germs will survive for a long time in sterilized water was announced by the eminent Dr. Roseneau as early as 1916. Water pollutes itself from what is washed.

Colloids in Water

Effect on Turbidity and Color

By C. H. CHRISTMAN
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WE are all more or less familiar with turbid waters which will not settle completely on long standing. The existence of coloring matter in colloidal condition has also been noted. Careful filtration of a raw water fails to remove some of this turbidity and color, and it is with this material that our interest centers at present. We are familiar with the fact that some waters can be efficiently coagulated with a minimum of chemical while others require many times this amount to secure the desired results. In some instances this condition may be due to the nature of the dissolved material, yet in others there seems to be a relationship between the nature of the suspended matter and coagulating dose. Some waters require very careful regulation of pH to secure good coagulation and in other instances this control appears to be unnecessary. In addition to matter which finds its way into water naturally, pollution from domestic and industrial sources add to the colloidal content of water.

It may be stated definitely that the presence of a colloidal condition in raw water does not mean that matter, so present, is organic or inorganic, from natural sources on a water-shed or from pollution. It may be from any or all of these sources. A colloidal condition indicates that matter of some type is present, not in true solution, yet in a state of sub-division in which the particles are separate entities, though submicroscopic in size. In fact, we believe that matter of vegetable and inorganic origin may occur in colloidal condition. With colloids resulting from pollution as well, it follows that each type will present a problem in itself when we consider the removal of the colloid by coagulation.

Differentation of Colloids. — Our knowledge of colloids and their characteristics indicates that some are acid, some neutral and some alkaline in character. Their reaction in an electrical field may be used to differentiate them into charged and uncharged colloids. It does not indicate whether they are of organic or inorganic origin. For this study, it is necessary to concentrate them by ultra-filtration through a suitable membrane and study them further. By connecting a battery or other source of direct current to electodes in a U-tube which contains a colloidal water, migration of the colloid occurs and coagulation may be observed at the electrodes. A critical study of this particular phenomenon should lead to the development of fundamental data which might be of importance in answering some of the problems relating to coagulation.

The present report must be considered as preliminary, in that phases of the study have not been completed. It is presented, however, with the hope that it will arouse the interest of others, precipitate thought and discussion, toward the end that our common knowledge of colloids in water supplies may be increased.

We have been concerned in particular with the occurrence of colloids in water, their prevalence, the nature of any charge they carry, their migration in an electrical field, the neutralization of the electric charge carried and its effect upon the existence of the colloidal state, the extent of the charge carried, any relation between colloids and pH, the existence of an iso-electric point or optimum pH at which they can be coagulated, together with such supplementary data as might be gleaned in the course of a study such as this.

Use of Ultramicroscope.—For this investigation, use has been made of an ultramicroscope. The cataphoresis cell contains the sample under investigation. It is provided with stopcocks for filling and draining. A capillary tube with a 1 mm. opening connects the two reservoirs, in which the platinum electrodes are sealed. The distance between the electrodes is 15 cm. The electrodes are connected to radio B batteries to assure sufficient voltage for migration rate studies. pH values were determined by colorimetric methods.

In using the ultramicroscope, water is placed in the cell with the level above the top stopcock. This is closed to prevent movement of the water during observation. A very strong beam of light is directed through condensing lens and upon the water perpendicular to the axis of observation. In this manner it is possible to observe the manifestation of a colloidal condition. The rays of light passing through the water strike a colloidal particle and are diffracted. This condition may be observed, for it is similar in character to the effect of a beam of sunlight in a dusty room. The individual particles, otherwise unseen, become apparent when light is reflected from their surfaces. Finding this condition in a raw water, we proceed to estimate the extent of the colloidal condition. This has been empirical thus far, but in future work it is planned to combine dialisis studies with the ultramicroscopic examination so that quantitative data may be available. Next, the cell is connected to the batteries and observation made to note migration of colloidal particles. If migration is observed, the direction of current flow is reversed to ensure that migration is due to the current rather than to movement of particles with water flow. In this manner we have observed particles flowing with the negative current toward the positive electrode.

Charged Colloidal Particles and Coagulation Requirements.—It has been our belief that colloidal particles which are charged might carry more or less of the electrical charge and this condition might be correlated to the coagulation requirements of the water. If the particles vary in the amount of their charge, attraction to an electrode under a constant current flow should vary and their rate of migration should be proportional to the charge carried. Ellms reports the measurements of colloids in Ohio River water as 0.29 centimeters per hour with a potential gradient of 4 volts per centimeter. The ocular of the microscope used in this work is fitted with a graduated scale. Movement of the colloids across this scale were observed and the time required for the movement across a measured distance was checked by a stop-watch. Observations were repeated and average values were obtained. It is worth noting that most of the samples showed little variation in the rate of migration, while some few gave wide variations. In this manner data were secured which rate the samples in terms of migration per centimeter per second per volt.

The samples were raw waters which were received in our laboratory for analysis. Coming from all sections, a wide variation in samples might be expected. The possible relation of other analytical data to the colloidal condition will be studied further and will be presented in a future report.

Colloidal Particles Charged with Electricity.—We have found that the colloidal particles in the raw waters studied are charged with electricity, the charge is negative in character, the rate of migration of colloidal particles induced by direct current varies and this variation is a function of the amount of charge carried. There seems to be no generic relation between the rate of migration and pH of the raw water.

Dispersion of colloids results from the similarity of charges which the particles carry. Neutralization of these

charges, by any methods, will remove the condition which prevents the coagulation of these colloids. The effect of the electric current has been demonstrated and is being tried on a plant scale at one of the larger plants in the west. The coagulants used in general practice give a colloidal condition under certain conditions and it is known that these colloids are positively charged. Thus, when colloids of opposite charge are mixed, there is mutual neutralization and precipitation. The effects of various colloids and the different coagulants are being investigated. It is possible that this will lead to the use of specific treatment for certain water conditions, giving better operation, greater control and improved water.

Water Treatment for Industrial Use

Recent Developments in Boiler Operation and Their Influence on Feedwater Treatment

By SHEPPARD T. POWELL
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LOCAL conditions have a marked influence upon feed water problems everywhere, yet fundamental knowledge on the subject of water conditioning is the foundation upon which the solution of the problem ultimately must rest. This conception of water treatment for industrial use now seems to be quite general among American engineers responsible for the safe and economic operation of steam generating equipment. Much time and effort has been expended in attempting to establish and carry forward broad fundamental research. As a result of such effort, at least two important investigations have been tentatively arranged. These are study of the mechanism of priming and foaming of water under steam conditions and the determination of the hydrogen ion concentration of concentrated boiler water under steam conditions. The necessity for such research is clearly apparent and the result of these studies should do much to improve our knowledge of two of the most perplexing problems in steam boiler operations, i. e., wet steam and corrosion of boilers and appurtenances.

It is difficult to justify a specific list of new appliances or processes in this or other fields without creating useless controversial discussion. We shall not attempt therefore, to do more than direct attention in a general way to indicated trend of developments.

The Most Recent Development.—Possibly the most interesting recent engineering development in feed water treatment has been the combination of various forms of water purification processes. The combination of chemical and zeolite softening, additions of coagulants with softening reagents, continuous blow-down system and steam purifiers has revolutioned feed water treatment. This has made possible a broader field for the designing engineer than previously was considered possible.

The conditioning of feed water is no longer limited to a single process but a series of corrective treatments. The arrangement and extensiveness of the design will depend upon the steam station requirements and economy resulting from the combination treatment. Recirculation of concentrated boiler waters has been used in the past but has not been widely employed. Recently a number of novel applications have been made which are attracting attention since they have some merit for specific conditions. In some of the designs recirculating only with heat recovery is effected while in others partial softening also takes place.

Increased Use of Softening Reagents.—No new chemicals of importance have been produced for water conditioning but there has been a very marked increase in the use of some softening reagents. This is particularly so in the case of phosphates and sodium aluminate. The increased use of the reagents is due primarily to purer products and more exact knowledge of their value for specific conditions. The investigations to determine methods of water treatments to inhibit embrittlement of boiler steel have been partially responsible for the increased use of phosphate. Both di and tri sodium phosphate have been used in the past. Mono phosphate has been now offered for this service. This product has some advantage over the other sodium salts since the desired soluble phosphate is obtained with a lesser concentration of the sodium radicle.

Electrolyte Methods.—Inhibition of corrosion of boilers, heaters and condensers by electrolytic methods has continued to attract attention and a number of successful installations have been made during the past few months. Research work has been conducted at at least two universities in an effort to determine the cause of this phenomenon. A number of theories have been advanced to account for this form of protection but experimental data is lacking which would account for the mechanism involved in the retardation of the corrosion rate.

A number of valuable contributions to the art of industrial water treatment have been made recently. Possibly the most constructive study in reference to the mechanism of scale formation has been the work of Dr. E. P. Partridge, conducted at the University of Michigan. The data presented by this investigator have thrown new light on deposition of scale forming solids and should prove of value in directing attention to future methods for controlling scale formation in evaporators and in boilers. Similar work is to be carried on by others along the same general line as pointed out by Dr. Partridge. The results of this work will be awaited with interest, since it may lead to revolutionary ideas in reference to the fundamental idea of scale growth.

The recent corrosion study by Dr. R. U. Evans has added much to our knowledge of film formation and the inhibition of corrosion by this action. Although this work is not a specific study in boiler water treatment, the scientific facts established have great application to the control of corrosion problems encountered in steam generation.

A number of very valuable contributions relating to embrittlement of boiler steel have been made through the Verein Deutscher Ingenieure. Likewise, the work of *Thiel and Luckman on the same subject will be found instructive in reference to German investigators' viewpoint on this important problem.

Many New Problems Encountered.—Many new problems have been encountered, which may not be solved without more intimate knowledge of the chemistry of water. The presence of non-condensible gases in steam, especially carbon dioxide, has given much concern to those responsible for steam station control. Acid steam from this source is much more frequent than is usually suspected. No solution for the control of the difficulty is at present available. The disassociation of even pure water in steel economizers, and superheaters has been shown recently to be a potential possibility under certain conditions. The detrimental effect on steel, from such disassociation products, is well known and must be avoided since the resulting damage is permanent and may be very costly. The problem may not be discussed intelligently since much study must be given to it over a wide range of conditions before the extent and acceleration of this destructive action on steel can be determined accurately. The report on this subject by Mr. C. H. Fellows to be presented at this meeting shows the potential possibilities of the disassociation of water. One industrial concern is now conducting similar experiments at pressures up to 4,000 lb.

The aim of this group to solve these numerous problems by cooperative effort has been recognized as a constructive program, to accomplish the desired results with the least duplication of effort. The influence of this movement has attracted attention from similar European groups and tentative plans have been arranged to have exchange of ideas with at least one of these cooperative research associations. International exchange of ideas leading toward the solution of these problems should be mutually beneficial.

There must necessarily be more or

*Committee report on feed water studies of the Association of Large Boiler Manufacturers.

less lost motion in carrying forward any cooperative work of this kind. There are so many specific problems that are peculiarly important to each group that it is not possible to confine the work of these committees to any specified plant control measures. The most that can result from the effort of this work is to establish fundamental concepts and to arrange these data for practical use. With a clear understanding of the problem based upon established facts as to the cause or causes of the specific phenomena, corrective treatment is fairy well assured.

Selecting Pumping Equipment

Some of the Broad General Principles

By A. P. PIGMAN
American Water Works & Electric Co., New York

THE engineer in selecting equipment for a pumping station may be confronted by an almost infinite variety of situations. Any fixed rule drawn from the solution of one problem is almost sure to be misleading in the solution of the next. Yet, in order to shorten his task and to make it more more nearly certain that the solution of each problem will be very close to the best solution possible, it is desirable that we discover, if we can, some broad general principles for his guidance.

Situations to Be Met.—In classifying situations to be met, we have to consider a great variety of things, such as the purpose of the installation—whether a new plant is to be built, or additional capacity added to an old plant, or more efficient equipment added to an inefficient plant. We have to consider the character of the service—whether it is to be single pumpage, double pumpage, or a combination of single pumpage with a ground water supply. The load may be uniform and vary only seasonably, or there may be wide daily fluctuations, superimposed upon seasonal fluctuations, and even the head may vary, especially when fire pressure must be raised. Finally, water works plants may vary in the quantity of water pumped and the head pumped against all the way from small stations requiring only 2 to 3 horsepower to large stations requiring thousands of horsepower. The variety of circumstances is almost without limit.

Table I

		Bhp.
Group 1		
	Average Load	above 1200
	Typical Plant av. load	1600
	Typical Plant max. load	2000
Group 2		
	Average Load	600-1200
	Typical Plant av. load	800
	Typical Plant max. load	1000
Group 3		
	Average Load	250- 600
	Typical Plant av. load	400
	Typical Plant max. load	500
Group 4		
	Average Load	below 250
	Typical Plant av. load	160
	Typical Plant max. load	200

Table II

		Steam	Diesel	Electric
Group 1	Fixed Charges	41,400	40,500	11,000
Av. Load	Labor	21,600	14,400	10,800
1600 Bhp.	Fuel or Energy	26,000	60,000	112,000
		89,000	114,900	133,800
Group 2	Fixed Charges	27,800	22,500	7,000
Av. Load	Labor	17,000	10,200	8,500
800 Bhp.	Fuel or Energy	16,200	30,000	56,000
		61,000	62,700	71,500
Group 3	Fixed Charges	20,200	12,900	3,400
Av. Load	Labor	14,400	8,000	6,400
400 Bhp.	Fuel or Energy	10,000	15,000	28,000
		44,600	35,900	37,800
Group 4	Fixed Charges	12,000	6,000	1,500
Av. Load	Labor	10,500	6,000	4,500
160 Bhp.	Fuel or Energy	5,000	8,000	11,600
		27,500	20,000	17,600

Classification of Types of Equipment.—To meet these situations, there are many types of pumping equipment, but at least one simple classification of these can be made based on the source of energy used for driving the pumps. Practically all pumping plants are operated either (1) by steam generated at the plant, or (2) by internal combustion engines, or (3) by electric energy purchased from the local power company.

Using a size classification based on the horsepower required to operate a plant, I have taken four typical plants and have made a comparison of the annual cost, including fixed charges on investment, of operating each of these four typical plants, first, with steam equipment, then with Diesel power and, finally, with purchased energy. Four series of studies are made of these four sizes of plants each using the 3 types of drive, steam, Diesel, and electric.

In the first series of studies it is assumed that the water is pumped only once; that is to say, the plant pumps either all raw water or all clear water. It is further assumed that there is a large reservoir in the system, so that the load is uniform, varying only seasonally. Finally, it is assumed that the problem is to build an entirely new plant. The 3 types of pumping equipment are fitted into this situation for each of the four sizes.

After this first series of studies, a study is made of the effect of double pumpage being substituted for single pumpage. Then the effect of a fluctuating load is investigated and, finally, the problem is reviewed in the light of merely adding new capacity to an existing plant rather than building an entirely new one.

Pumping stations have been divided, more or less arbitrarily, into four groups (see Table I) based on the brake horsepower required to carry the average load. For each group, a plant requiring an average horsepower somewhere near the middle of the group is taken as typical.

As a working basis in all of these studies, the cost of coal is taken to be $3.00 per ton, the cost of Diesel engine oil 6 ct. per gallon, and the cost of electric energy including demand charges, 1 ct. per K.W.H.

Summary of Four Typical Cases.—1. When a new plant is to be built for single pumpage at a nearly uniform rate a steam plant will usually be the most economical provided the load is sufficient to call for turbines of more than 1,500 horsepower capacity. (See Table II.)

2. For similar plants with loads averaging less than 250 horsepower the electric plant will ordinarily be most economical but, if the power rates are high, the Diesel plant will be better.

3. In between these the field is highly competitive for the three types of equipment with the Diesel having ordinarily a slight advantage which tends to give way to the steam plant in the upper ranges and to the electric plant in the lower ranges.

We next consider the effect of pumping the water twice instead of once in each of the four cases. It is assumed that first raw water is pumped against a head of 50 ft. and that clear filtered water is pumped against the remaining 250 ft. It is suggested that for each of the three types of equipment the low service pumps and pit will cost approximately the same for in the case of the steam plant or the Diesel engine plant the most economical arrangement is to have small centrifugal low service pumps driven either by water turbines or electric motors, taking the energy either from water pumped by the main high service unit or from a generator driven by that unit. The added cost for the extra equipment in the case of the steam and Diesel plants beyond what would be added for the electric plant will be small amounting to about the following:

	Investment	Fixed Charges
Group 1	$15,000	$2,250
Group 2	10,000	1,500
Group 3	6,000	900

Obviously this is not enough to appreciably affect the relative standing of the three types of equipment in the three cases.

Fluctuating Load.—If the plant to be built is to have a fluctuating load instead of merely seasonal variations, the effect on the results obtained in the first series of studies is considerably more marked. The three series of studies considers this situation and assumes that the load fluctuates sufficiently for

Table III

		Uniform Load	Fluctuating Load	New Unit Added to Old Plant
Group 1	Steam	89,000		
Av. Load	Diesel	114,900		
1600 Bhp.	Electric	133,800		
Group 2	Steam	61,000	71,500	47,100
Av. Load	Diesel	62,700	70,200	55,600
800 Bhp.	Electric	71,500	79,800	70,600
Group 3	Steam	44,600	52,600	33,400
Av. Load	Diesel	35,900	40,200	34,200
400 Bhp.	Electric	37,800	39,700	37,800
Group 4	Steam	27,500		20,900
Av. Load	Diesel	20,000		17,900
160 Bhp.	Electric	17,600		17,200

the maximum load to be twice the average. The effect is shown in the second column of Table III.

The average load has remained the same, hence fuel and labor costs have remained the same. This may not be strictly true because due to the greater fluctuation in load equipment cannot be kept operating at all times in the regions of best efficiency, but, if the nature of the load has been carefully studied before hand and the equipment carefully selected, there need not be very much loss.

The peak load being 60 per cent higher, 60 per cent more equipment and hence 60 per cent more investment is needed. This influences adversely the steam and Diesel plants where fixed charges represent the largest portion of the total. Thus we find that steam and Diesel plants have lost some of their advantage in the two larger groups and that the electric plant takes first place in the third group and increases its lead in the fourth group.

Adding Equipment to an Existing Plant.—The fourth and last series of studies assumes that instead of building a new plant the problem is to add more capacity to an existing plant. (See Table III.)

Here the effect on the original four studies (see column 3 of Table III) is exactly the reverse of the effect of a fluctuating load. Again the fuel cost has remained unchanged but since no duplication of equipment has to be provided for, the amount of equipment needed is less and hence the plants which require large unit investments are benefited. We find now that in group 2 the steam plant has gained a considerable advantage and even in group 3 it now shows the lowest annual cost. Even in group 4 the cost of Diesel oil need only go to 8 ct. and of electricity to 1 1/3 per KWH. for the steam plant to show up as well as the other two.

If the added capacity is for meeting peaks only the Diesel or electric plant may regain their advantage over the steam plant.

Even if new capacity is to be used for regular service the steam plant should not be given the full advantage indicated by the third column of Table III if the existing equipment which will serve as standby is old and in bad shape and will have to be discarded in a few years.

There are many small plants smaller than the typical plant of group 4 pumping a million gallons per day or less where for the sake of convenience alone an electric plant may be justified even at a slightly higher cost since the amount involved cannot be great.

Reciprocating Pumps.—In all four studies the steam plant has been worked up on the basis of turbine drive. In the two large groups a reciprocating pump is practically out of the question but in the two smaller groups there will be occasions where the highly efficient crank and fly-wheel pump will make as good a showing as turbine driven units. Since, however, in the building of new plants a steam plant can generally be justified only in the larger sizes, this means that the installation of new reciprocating pumps is practically limited to a portion of the cases where steam equipment of any kind can be justified in making additions to existing plants. It is pointed out, however, that, where these highly efficient crank and fly-wheel pumps are in good operating condition and additional pumping capacity is not needed, there is no possibility of installing any other type of equipment for the purpose of reducing operating expenses.

General Summary.—We have passed in review a large variety of situations to be met in the installation of new pumping equipment. We have attempted to classify these situations and to show that under one set of circumstances one type of equipment generally had an advantage and in another set of circumstances another type generally had the advantage. Hardly anywhere, however, have we found that any type of equipment has an undisputed field. Even in the cases where one type of equipment seemed to have the greatest advantage over the others, our analysis showed that a change from what might be considered an average in the cost of coal, of oil or of electric energy, would make another type more suitable.

In general we found that for a new plant having a uniform pumpage rate a steam plant generally had quite an advantage, provided the plant was large enough to justify the installation of a turbine of more than 1,500 horsepower. On the other hand, if the horsepower required were less than 250 or 300 the electric plant generally had an advantage. In between these sizes the Diesel plant had a slight advantage but was closely competitive with steam as the sizes approached the upper limit and with electricity as the sizes approached the lower limit.

We found further that whether the pumpage was single or double pumpage made very little difference.

We next found that if the load had wide fluctuations more equipment was required to handle the same average load and, therefore, the low unit investment of the electric plant was given a greater advantage than it possessed in the case of the uniform load and its field accordingly expanded.

On the other hand we found that if instead of building a new plant the problem were to add capacity to an existing plant the amount of equipment required to take care of a given load would be less and the steam and Diesel plants with their low operating costs would be given a greater advantage than they possessed where a new plant was to be built and the field of these plants was, therefore, expanded down into smaller sizes than otherwise.

Ground Water in Yellowstone and Treasure Counties, Mont.

The Department of the Interior announces a report entitled "Ground Water in Yellowstone and Treasure Counties, Montana," by George M. Hall and C. S. Howard, just issued. The report, which is listed as Water-Supply Paper 599 of the Geographical Survey, was prepared in cooperation with the state engineer of Montana, the department of chemistry of the Montana State College and the water laboratory of the Montana State Board of Health. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 25 cents a copy.

These two counties are traversed by the Yellowstone River, and on the lowlands near the river wells generally yield large quantities of water, although much of it is of poor quality. On the upland in many places the inhabitants have difficulty in finding adequate supplies of good water even for domestic use. A careful study of the geology has shown that in some places where the surface conditions appear to be unfavorable or where the water is of poor quality, good supplies may be obtained by drilling to deeper formations. The Geographical Survey report gives not only general descriptions of the rock formations but also more detailed discussions of the conditions governing the occurrence of ground water in each of the more than 100 townships that lie in the two counties.

The report contains data in regard to 100 wells, with analyses of water from them and other information in regard to the quality of the water. It also contains a geologic map showing the distribution of the rock formations, cross-sections showing the geologic structure and notes in regard to the unusual natural features of the region.

Activated Sludge Plant Operation in Great Britain

Experiments at Reading, England, Discussed in Paper Before Royal Sanitary Institute

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A GENERAL idea seems to have prevailed that the process is a simple biological one wherein a specific micro-organism oxidizes the impurities of sewage, and Dr. Calvert has cited the vinegar process as analogous to the popularly accepted theory. In this process, it will be remembered that a specific bacterium does in aerobic conditions actually oxidize alcohol to acetic acid.

In attempting to deal with some of the difficulties encountered in the activated sludge plant which has been installed for the Reading Corporation, the writer was forced to the conclusion that many of the empirical rules and ideas commonly adopted in the operation of such plants are not really generally applicable, and that the process cannot properly be described as simply biological.

The Velocity of Reaction.—In commencing the study of a reaction by physical chemistry methods, one of the first steps is, usually, to consider the velocity. The recation that is, of course, under investigation in the activated sludge process is the removal of the impurities in the sewage, and the results obtained can be most conveniently studied if plotted as a curve, the slope of which will indicate the rate of removal of the impurity, i. e., the velocity of reaction.

Since in their paper (Society of Chemical Industry, Jan. 3, 1927) Messrs. Butler and Coste referred to this instantaneous effect and considered it was appreciable, we endeavored to devise a critical experiment in order to show whether or not this was the case. The experiment was as follows:

Sewage was allowed to settle overnight and the supernatant liquid only used.

Into three 500 c. c. cylinders were placed:

1st cylinder—150 c. c. sludge (settled for one hour).

2nd cylinder—150 c. c. effluent from which the sludge had been settled.

3rd cylinder—150 c. c. distilled water.

Sufficient carefully mixed settled sewage was added to each to bring the total volume to 500 c. c., and the mixtures in the cylinders therefore consisted of 70 per cent sewage with (1) 30 per cent sludge; (2) 30 per cent effluent; (3) 30 per cent distilled water. The cylinders were each turned over twice thoroughly to mix the contents, allowed to stand for one hour, the supernatant liquids poured off and examined, with the following results:

Experiment T29
*Oxygen absorbed in three minutes; parts per 100,000

	1	2	3
	30 per cent sludge	30 per cent effluent	per cent distilled water
Results found	1.42	1.56	1.46
Results calculated	1.60	1.60	1.47
Difference—			
Instantaneous effect	0.18	0.04	0.01

The sludge for the experiment was in excellent condition for clarification, and it is to be noted that the liquids were not filtered, but were settled for one hour. There was a small amount of fine suspended matter (sludge particles) in the effluent used in No. 2.

The "instantaneous effect" is seen to be slight, and we venture to suggest that the results obtained by Messrs. Butler and Coste were due to the fact that their mixtures were filtered. The experiment does, however, show that even if sludge is allowed to fall but once through sewage, there is some removal of impurity as could very well be predicted from our knowledge of adsorption effects or of the action of enzymes.

The next point which must strike the observer is the enormous rate at which the three minutes oxygen absorption figure drops.

First Action in Process.—Examination of the effluent reveals that clarification has been achieved by the time the oxygen absorption curve flattens out to an approximately horizontal line, and it has been asserted on many occasions that the first action which normally occurs in the activated sludge process is clarification or the removal of colloids. Whilst objections have been advanced against this opinion, the following considerations seem to us conclusive:

1. The process may be interrupted at the point when clarification is achieved, and before little or any nitrates or nitrites are found.

2. Only an abnormal sludge, prepared usually by very prolonged aeration without sewage will nitrify first, but such a sludge will fail to clarify.

3. A sludge which will clarify well, but will not nitrify can be produced in two or three weeks, whilst the preparation of a nitrifying sludge requires a much longer time.

4. The Birmingham flocculated sludge process is a large scale demonstration that clarification is a distinct process, and is the first stage of the activated sludge process.

Three Distinct Stages.—That there are distinct reactions or "sections" in the process was recognized by Ardern and Lockett in their original paper (Society of Chemical Industry, May 30, 1914), but neither of these workers nor others seem to have pursued their studies very far in this direction.

Consideration of these and many other points has led the author to the conclusion that in the activated sludge process at least three distinct stages must be recognized:

1st stage—Clarification.

2nd stage—Reactivation or restoration of the powers of clarification.

3rd stage—Nitrification.

Stages 2 and 3 may go on simultaneously, and whilst stage 2 is absolutely necessary for the maintenance of stage 1, stage 3 is not necessary.

Granted the correctness of the foregoing deductions, the writer ventures to submit the following notes upon the first or clarification stage.

The Clarification Stage.—The term "Clarification" must be understood to signify not only the removal of colloidal matter, but also removal of some substances from true solution, as well as, of course, any matter in actual suspension, This use of the term is, of course, similar to its use in describing the clarification test modified by Fowler and Ardern for the approximate estimation of colloidal matter in sewage.

It has been said that the clarification of sewage when it is agitated with activated sludge may be due to:

1. A scrubbing effect.

2. Combustion or combination of the impurities with oxygen.

3. Induced combustion brought about by catalytic action of the activated sludge.

4. Biological action, including (a) carbonaceous fermentation, (b) proteolysis, (c) direct cell action.

5. Physical action, such as absorption of the impurities in or upon the sludge.

6. Combinations of some of these actions.

Let us deal with these statements in turn.

Scrubbing.—It is difficult to understand what is meant by "scrubbing" in this connection. One supposes it may

*The three minutes oxygen absorption figures for settled sewage and effluent were 2.10 and 0.42 respectively, and the calculated results in the above table are arrived at from these figures.

be intended to convey the idea of more or less violent interfacial contact. Quite how this could affect purification is not clear, but in any case the writers have never seen any arguments adduced that carry the suggestion very much further.

Combustion: Induced Combustion.—If clarification really is combustion either with or without the aid of catalysts (and enzymes are catalysts) then it follows that oxygen is necessary for the combustion. This being so, oxygen must be obtained either from solution (that is, from the atmosphere or applied air) or alternatively is stored up in the sludge during reactivation.

This point can be studied experimentally, but while it is a simple matter to investigate the reaction when atmospheric oxygen is excluded, it is not so easy to eliminate all oxygen or oxidizing agents from the sludge while retaining its active character. On the other hand, examination of the sludge does not reveal any large store of free oxygen, the presence of nitrates or nitrites being immaterial since clarification can quite well (or perhaps even better) be performed by a sludge which is incapable of oxidizing ammonia.

Clearly if clarification is a combustion process, it could not occur to any appreciable extent in the absence of aeration, and the following experiment was undertaken to prove that aeration is not essential:

Experiment to Prove that Aeration is Not Essential.—Sewage was used which had been settled overnight to remove all but the finer suspended matters. The activated sludge used was in good condition, and had been thickened by settlement for one hour.

To separate quantities of the settled sewage sufficient sludge was added to give the proportions stated below.

Series A was performed in bottles two-thirds full only, and the stoppers were removed from time to time to slightly renew the air.

Series B was performed in completely filled and well-stoppered bottles; no air being admitted.

The bottles were all shaken by hand for one hour, the aim being to keep the sludge from settling and on the move all the time.

At the end of the one hour of agitation all were settled one hour, the supernatant liquids were decanted off, and the effluents examined.

Oxygen Absorbed in Three Minutes, Parts per 100,000 Settled Sewage 1.78

	A (aerated)	B (not aerated)
5 per cent sludge	1.40	1.58
10 per cent sludge	1.34	1.38
15 per cent sludge	1.14	1.32
20 per cent sludge	1.04	1.20
25 per cent sludge	0.94	1.28

The experiment shows that whilst air assisted and improved the action, the clarification stage can go on in the absence of aeration.

Experiment No. T.49.—Experiment T.49 is a variation of the above, but in this experiment, whilst series A was agitated in 500 c. c. cylinders by means of compressed air from an open glass tube, series B was agitated by gently inverting, shaking, and swirling in stoppered bottles. In this case, instead of different amounts of sludge, the sewage was diluted to different extents by means of distilled water.

Sewage settled overnight was used, and the mixtures were agitated or shaken for half an hour, then settled for one hour.

Three Minutes Oxygen Absorption, Parts per 100,000*

	Calculated figures for mixture excluding clarification	Observed figures Series A (Aerated)	Series B (Not aerated)
Settled sewage, plus 10 per cent sludge	1.75	1.44	1.48
67.5 per cent settled sewage, plus 22.5 per cent water, plus 1 per cent sludge	1.33	0.98	1.08
45.0 per cent settled sewage, plus 45.0 per cent water, plus 10 per cent sludge	0.90	0.62	0.70
22.5 per cent settled sewage plus 67.5 per cent water, plus 10 per cent sludge	0.48	0.38	0 42

Again it is shown that clarification takes place in the absence of air, but is improved by its addition.

The experiments just quoted do not, of course, rule out the possibility that there may be a store of some oxidizing agent in the sludge itself, but the fact that nitrates or nitrites need not be present while clarification is taking place almost eliminates them from the problem. If there is an oxidizing agent present in the sludge it has not been identified. There is not, however, any evidence (so far as the writer is aware) that any really extensive amount of oxidation does not take place at this stage.

Buswell, in experiments on the relative importance of oxygen and stirring, concluded that stirring is more important (in the clarification stage) than oxygen, and that activated sludge will function at oxygen levels so low that they can scarcely be measured.

It may be accepted then that although aeration during clarification may help, it is not essential to this stage.

Carbonaceous Fermentation. — This term has been much used and signifies the conversion by bacterial agencies of complex carbon compounds into simpler carbon compounds with evolution of carbon dioxide or other gas, the process being analogous to true fermentation. The evolution of the gas is essential to the action.

There is at present little, if any, evidence of such action during the clarification stage. This is borne out by Messrs. Crawford and Bartow, who, in 1916, at the University of Illinois, found that the carbon dioxide content of the effluent air remained low for two or three hours, after which it considerably increased, and they conclude by saying: "Strong bacterial action does not take place for the first few hours." It is possible that fermentation may take place with more or less vigor at later stages.

*The three minutes figures for settled sewage and effluent from sludge (interstitia liquid) were 1.88 and 0.56 respectively.

Proteolysis.—While there may be some slight hydrolysis of proteins during clarification, it seems unlikely that there is any extensive splitting of proteins during this stage.

The albuminoid nitrogen elimination curve certainly follows very closely the three minutes oxygen absorption curve, but since there is in the ultimate result an accumulation of albuminoid nitrogen as represented by surplus sludge, hydrolysis or destruction can only be slight. Again when, under usually anaerobic conditions, hydrolysis of proteins (i. e., putrefaction) does occur, there is generally (if not invariably) production of ammonia, and were there extensive hydrolysis of proteins at this stage there would almost of necessity be an increase of ammoniacal nitrogen.

In practice, however, there is no increase of ammoniacal nitrogen in the clarification stage, but rather (if the sludge is capable of nitrification), a diminution, from which it follows that if there really is hydrolysis of proteins at this stage, it must be assumed that the ammonia produced (and the alkalinity resulting), must be removed or destroyed as quickly as produced.

Direct Cell Action.—In regard to the suggestion of direct cell action, i. e., absorption of the impurity through the cell walls of living micro-organisms, a few observations may be given.

Direct cell absorption would be by osmosis if bacteria are the micro-organisms operating. It is thus extremely unlikely that colloidal matter could be absorbed directly into the cell, although it is true that the living cell could, and probably does, absorb matters from true solution, but enzymic action would be necessary before the colloidal matters were broken down to a suitable condition for direct absorption. If bacteria are responsible for clarification, it should be possible to prepare the enzyme they secrete, and the enzyme (or enzymes) could be expected to perform the work in sterile conditions and in the absence of the bacteria.

Any action involving catalysis or enzyme action, removal, coagulation, or even presence of colloidal matter; or any action involving great areas of surfaces, may often with advantage be examined in the light of our present knowledge of adsorption, the mathematical theory of which was worked out by Willard Gibbs and independently by Sir J. J. Thomson, and may be stated in the form of the adsorption equation.

When—

X = the amount of substance removed (by adsorption).

M = mass of adsorbent in grams (really area of surface is the factor involved).

C = the equilibrium concentration, i.e., the amount of substance left.

a = a constant for the substance being removed.

n = a constant for the adsorbent.

$$\frac{X}{M} = a C^{\frac{1}{n}}$$

or $X = aM\sqrt[n]{C}$ or in words:

The amount of substance removed by unit quantity of an adsorbent varies according to:

1. The nature of the substance being removed.
2. The adsorbent employed.
3. The nth root of the equilibrium concentration. The value of n is usually between 2 and 10.

Since the amount of substance removed depends upon the nth root of the equilibrium concentration, adsorption reactions are much less dependent on initial concentration than ordinary chemical reactions, and adsorption goes on quite effectively in very dilute solutions; in fact, the adsorption equation is only accurate for dilute solutions.

Experiment T.48.—Sewage had been settled overnight.

Into separate 500 c.c. cylinders were placed the following mixtures:

(a) 25 c.c. sludge plus 25 c.c. interstitial effluent plus 450 c.c. sewage.
(b) 50 c.c. sludge plus 450 c.c. sewage.
(c) 50 c.c. sludge plus 337.5 c.c. sewage plus 112.5 c.c. 22½ per cent distilled water, 10 per cent.
(d) 50 c.c. sludge plus 225 c.c. sewage plus 225 c.c. distilled water.
(e) 50 c.c. sludge plus 112.5 c.c. sewage plus 337.5 c.c. distilled water.

The mixtures in the cylinders were then agitated by means of a slow stream of air bubbles sufficient only to keep the sludge from settling, but avoiding aeration to any extent. The bubbles were admitted through open-ended glass tubes of about the same diameter, and each supply was adjusted to about two bubbles per second.

After half an hour of agitation the air supply tubes were removed, and the sludge allowed to settle for one hour, at the end of which the supernatant liquid was decanted off and examined.

Oxygen Absorbed in Three Minutes—Parts per 100,000

Settled Sewage 3.02 parts per 100,000.
Settled Sewage after "Clarification Test" 2.16 parts per 100,000.
Effluents after half-hour agitation and 1 hour settlement.
10 per cent sludge with various dilutions of settled sewage.

	O Abs. in 3 min. C	Log. 10C.	Amount removed X	Log. 10X.
(a) 90 per cent S. S., 5 per cent interstitial water, 5 per cent sludge	2.52	1.4014	0.50	1.0000
(b) 90 per cent S. S., 10 per cent sludge	2.14	1.3304	0.88	.9445
(c) 67½ per cent S. S., 22½ per cent distilled water, 10 per cent sludge	1.68	1.2253	0.59	.7671
(d) 45 per cent S. S., 45 per cent distilled water, 10 per cent sludge	1.12	1.0492	0.39	.5911
(e) 22½ per cent S. S., 66½ per cent distilled water, 10 per cent sludge	0.60	.7782	0.16	.1903

If $\log C$ and $\log \frac{X}{M}$ (or $10\ C$ and $10 - \frac{X}{M}$ for convenience) be plotted the curve is almost a straight line. This signifies that the clarification action approximately follows the adsorption equation. This result was confirmed by repetition of the experiment on a number of occasions. Different amounts of sludge and different times of agitation were employed, but the adsorption equation was fairly closely applicable.

The classes of reactions already known to follow this equation are:

1. True adsorptions, e.g., by charcoal or other similar well-known adsorbents.
2. Catalytic actions.
3. Enzymic actions.

Knowing that the adsorption formula is applicable, one is enabled to understand why the reaction can efficiently take place even in such very dilute mixtures as ordinary sewage, for if the supply of adsorptive or catalytic surface (or the amount of enzyme) is adequate, the initial concentration of the sewage has little effect on the equilibrium concentration, i.e., the amount of impurity left. Further, adsorption, catalysis, and enzyme action are all surface actions, and as such depend on the initial state of the active surfaces. This being so, there is an obvious necessity for a reactivation stage during which stage the active surface is renewed.

The agreement with the adsorption formula, loss of activity during clarification and restoration of this power of clarification during re-aeration leads to the important inference that the real biological work is done during re-aeration when the enzymes (and perhaps other products) are produced, whilst the actual clarification stage represents little more than a physical or chemical reaction of the enzymes.

Experience on Percolating Beds.—It is highly desirable in studying the activated sludge process that the 30 years or so of research and experience on percolating beds should not be lost sight of, and an experiment of Scott-Moncrieff throws very great light on the theory of both percolating filters and of the activated sludge process. In 1898 he constructed a filter of superimposed trays of media, and found that if the sequence of the trays was altered the action of the filter was impeded. Not until the original conditions were again established could proper purification be obtained.

We know today that clarification takes place in the upper part of the percolating filter and that nitrification occurs below. The percolating bed, then, in a fairly efficient manner separates the clarification and nitrification stages.

When Scott-Moncrieff tried to reverse the order of the stages he was obviously trying to reverse an order which had naturally established itself, and we may be very sure that there must be some sound reasons for the national establishment of this particular order of stages. Study of these reasons cannot fail to be of great importance.

Stages of the Activated Sludge Process.—It seems almost impossible to avoid the inference that the activated sludge process should be separated into stages for the more efficient operation of each stage.

The stages which suggest themselves now are:

1. Clarification.
2. Reactivation of restoration of the powers of clarification.
3. Nitrification.
4. Reactivation of the special nitrifying sludge (if possible).

Although logical to split the process into stages, it must, of course, be recognized that economic considerations must prevail, and until we have learned to conduct each stage at its maximum speed and efficiency, it may be cheaper to carry on with a comparatively slow combined stage process.

Sewage Effluent Tasted Good, Anyway

The Ohio Health News of July 15 is responsible for the following:

"From an isolated school district in the northern part of the state, where the board of education, some time ago, installed sewage treatment works, comes an authenticated story of two fishermen who drank of the effluent and found it good. According to the clerk of the board of education, two men were fishing in the stream into which the effluent drains through a tile. They noticed some clear water flowing through the tile, and drank of it. Going up through the farm to the house, they commented to the farmer on the excellence of the water, and asked him if it came from a spring. It was about the best water they ever drank, they said, and they remarked 'how nice it would be' if they could have such water piped into their homes in the city.

"When they were told where it originated, the water did not seem quite so attractive to them for drinking purposes—but that is a matter of esthetics."

Forestry to Protect Reservoirs

The City Waterworks Department of Akron, O., has developed a transplant nursery in which more than 200,000 seedling trees are growing to a size that will enable them to compete with heavy sod, according to reports to the United States Forest Service. In Barberton, O., the City Waterworks Department began planting on a large scale this year, and plans, along with the reforesting of idle land, to develop a wide shelter belt of pine or spruce all around the large city reservoir. Such a shelter belt prevents much debris from being carried into the water, in addition to acting as a soil binder.

Qualifying Bidders on Public Works

Report of Committee of City Engineers Association of New York State

The prequalification of bidders on public works was recommended by a committee of the City Engineers Association of New York State in a report presented Sept. 27 at the fall meeting of the association. The committee consisted of Harry R. Hayes, chairman, Albany, N. Y.; M. W. Plumb, city engineer, Malone, N. Y.; and Leonard Bergman, city engineer, Jamestown, N. Y. The report and the proposed law follow in full:

Your committee feels that it is an essential duty of a public official to endeavor to eliminate some of the many difficulties which now attend the administration of public works. We appreciate that it is in the interest of the public that every effort should be made to guarantee the prosecution of public work with the greatest degree of efficiency. Losses, delays and inconvenience to the public have been seriously encountered on many public construction projects.

The cause, in many instances of unsatisfactory performance of public work, is due to the fact that the successful bidder is not competent to thoroughly undertake the contract, and lacks either the professional skill, organization, or financial ability to properly complete the project.

Such situations are the result of the present system of awarding contracts to any concern who can furnish a bond. The furnishing of a bond does not in any way guarantee the responsibility of a contractor. The bonding companies have repeatedly made such assertion. The bond is only an assurance that if the contractor fails that the bonding company will assume the obligation of the contract.

The courts have held in numerous instances that it is the plain duty of the contracting public body to investigate the qualifications of a bidder before making an award. This right has not been very generally exercised in this state. Possibly due to the different interpretations of the word "responsibility" as applying to public contracts and because the laws pertaining to the award of public contracts have not definitely expressed the authority which the courts have held that public officials do possess.

It is the opinion of your committee that the policy of qualifying bidders should be adopted in some form. There are two methods which may be adopted. Either to examine the qualifications of a bidder before proposals are received or to determine them after the receipt of bids. In either method the plan of investigation could follow that outlined in the "Standard Questionnaire" recommended by "The Joint Conference on Construction Practices." This conference included committees from: American Association of State Highway Officials, American Institute of Architects, American Institute of Consulting Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers, American Society for Municipal Improvements, Associated General Contractors of America, Highway Industries Exhibitors Association, National Association of Casualty and Surety Agents, Surety Association of America.

Your committee feels that every public body should have some plan whereby the fitness of a bidder to assume a specific contract can be determined. To be most effective, however, the qualifying procedure should be carried out before the bidder is allowed to obtain plans and specifications.

This system avoids such unpleasantness as charges of favoritism when it becomes necessary to reject the bid of an unqualified contractor after the proposals have been received. It assures the contractor the award if his bid is low. It gives the public body the opportunity to establish a qualified list of contractors and to arrange them in classes according to the magnitude or size of the contracts upon which they can qualify.

Your committee, therefore, believes that the most satisfactory system of qualification is the one which requires it prior to the reception of bids and therefore, recommend the approval of the following law.

Proposed Law for Prequalification of Bidders

1. Every officer of the State government, or of any city who is charged with the duty of receiving bids for or awarding a contract for the construction of a public improvement shall, before furnishing plans or specifications or proposals therefor to any prospective bidder desiring to submit a proposal for the construction of such improvement, require that person to submit a full and complete statement, duly verified, of his financial ability, equipment, experience in the construction of public improvements, and of such other matters as the officer may require to assist him in determining the qualifications of that person to undertake and fully perform, in a satisfactory manner, the work contemplated. Such statement shall be filed with the written answers to questions propounded in a standard form of questionnaire to be furnished by the officer to all prospective bidders, and shall be filed with the officer not less than five days prior to the day upon which bids are to be opened.

2. Before the bids submitted for the construction of a public improvement are opened, the officer charged with the duty of awarding the contract for the construction thereof shall consider the statements so filed and determine to his satisfaction those prospective bidders who are duly qualified to undertake and fully perform in a satisfactory manner, the work required; and no contract for the construction of a public improvement shall be awarded to any person, who in the opinion of the officer, is not thoroughly qualified to undertake and fully perform the work in a satisfactory manner, or who has not filed the statement as provided herein.

3. The officer may, at any time after due consideration of the statement filed by any prospective bidder, notify such bidder that he is qualified or not qualified, as the case may be, to undertake and fully perform, in a satisfactory manner, the work contemplated, and it shall be the duty of the officer to make a public announcement, immediately before the bids are opened, of such persons to whom plans, specifications or proposals have been furnished who are deemed to be fully qualified to satisfactorily perform the work required.

4. When any one person shall be the low bidder on two or more contracts for the construction of public improvements neither of which has been awarded, and such person is not in the opinion of the officer, qualified to undertake and fully perform, in a satisfactory manner, the work contemplated under all of such contracts, the officer shall require that person to immediately withdraw one or more of his bids and shall award to that person only such contract or contracts as he shall deem qualified to undertake and perform.

5. No action or proceeding of any nature or description out of any court of competent jurisdiction shall lie against any officer of the state government, or of any city, because of his refusal to award to any person a contract for the construction of a public improvement for the satisfactory performance of which such person is not, in the opinion of the officer, fully qualified, or who has failed to comply with the provisions of this chapter.

6. The term "person" as used herein, means any individual, co-partnership, association, corporation, or joint stock company, their lessees, trustees or receivers.

The term "officer" as used herein, means any officer, board, commission, committee, department or other branch or bureau of the state government, or of any city.

7. This chapter shall apply only to contracts for public improvements, proposals for the construction of which are required to be advertised for by law.

The term "public improvement," as used herein, shall mean an improvement upon any real estate belonging to the state, or to any city.

8. This act shall take effect immediately.

Results of Experiments in Determination of Biochemical Oxygen Demand

Paper Presented March 23 before
New Jersey Sewage Works Association

By LEROY FORMAN
Senior Chemist, Bureau of Engineering, New Jersey State Department of Health

THE biochemical oxygen demand determination of crude sewage, sewage plant effluents, trade wastes, and polluted streams has become generally recognized as an important test for determining their strength, degree of purification, and character of pollution; and discussions of procedure for carrying out the determination are becoming more and more frequent. At the present time there seems to be a great need for standardizing a procedure whereby uniform and consistent results, that will check, can be obtained.

This was demonstrated to me most forcibly last fall when through necessity a number of bichemical oxygen demand determinations were made up in the field and carried around in a machine three days before they could be brought to the laboratory for completion. The results on raw samples were around 60 parts per million of biochemical oxygen demand, which seemed ridiculous and all out of proportion in view of the apparent strength of the sewage both by appearance and as indicated by the figures obtained in the various other chemical determinations. Soon thereafter, the following experimental work was undertaken, which I believe covers the various factors entering into the biochemical oxygen demand determination.

Temperature of Aeration of Diluting Water and Aging.—Portions of distilled and tap water were aerated at two temperatures, 50 deg. F. and 74 deg. F., and after a few minutes when all visible entrapped air had disappeared their dissolved oxygen content was determined. They were then allowed to stand at room temperature stoppered, and dissolved oxygen determined each day.

The water aerated at 50 deg. F. contained 11.8 parts per million of dissolved oxygen; whereas that aerated at 74 deg. F. contained 9.1 parts per million. After two days the former lost 3 parts of oxygen and the latter 0.8 parts. It required eight days standing at room temperature for the two waters to reach the same oxygen content.

A number of samples from time to time of freshly aerated water were allowed to age a week or more and the rate of loss of dissolved oxygen noted. From 0.4 to 0.7 parts per million were lost within a week with water that was not saturated when aerated. With a strong sewage, 2 per cent is mixed with 98 per cent of dilution water; it is very essential then to have a diluting water that has been sufficiently aged as the results obtained must be multiplied by 50 to obtain the biochemical oxygen demand. Freshly aerated distilled water even though not saturated when put in bottles and incubated at 20 deg. C. loses a certain amount of oxygen.

Temperature of Incubation. — One liter of a 2 per cent solution with each of ten samples of sewage from as many towns was made both with distilled water and Trenton tap water that had been aerated and aged at room temperature for two weeks. Three bottles of about 250 c. c. capacity were filled from each liter and one set was incubated for five days at 10 deg. C., another at 220 deg. C., and the third at 31 deg. C.

It was found that the average variation was 5.06 per cent in the ten samples for each degree centigrade between 10 deg. C. and 22 deg. C. incubating temperatures when distilled water was used for dilution, and 3.90 per cent when tap water was used. Between 22 deg. C. and 31 deg. C. incubating temperatures, the average variation for each degree was 0.91 per cent with distilled water and 0.93 per cent with tap water. It was noted that in nearly every instance dilutions made with tap water seem to give higher results than dilutions made with distilled water.

Results of Using Distilled and Trenton Tap Water For Dilution Purposes. —The two waters were aerated at room temperature (74 deg. F.) and allowed to age two weeks before use. The incubation temperature for the diluted sewages was 20 deg. C. In this series 23 samples of sewage from six towns were used consisting of 10 raw sewage samples, 10 Imhoff tank effluents, 1 sprinkling filter effluent, 1 secondary settling tank effluent, and 1 creek water, all run in duplicate.

The average biochemical oxygen demand for the entire 23 samples was 145 parts per million with distilled water and 180 parts per million with Trenton tap water, an increase of 35 parts per million with tap water. When divided into the different kinds of sewage the results are shown in Table I.

The per cent difference between the distilled and tap waters is about the same for the raw and tank effluents; namely, 24.4 per cent and 24.1 per cent respectively. The figures using the two kinds of water for the secondary treatment effluents are fairly close.

The greatest difference in parts per million of biochemical oxygen demand in the check determinations on the same sample was 30 with distilled water and 20 with tap water; the average with distilled water, 11.1 parts per million, and with tap water, 6.07 parts per million; while standardizing temperature of aeration of dilution water, aging and temperature of incubation shows considerable improvement in obtaining closer checks and more consistent results, tap water gives higher and still more consistent and closer checks. It was then thought that the difference between the pH value of the two waters might be the answer. The pH value of the distilled water used was 7.1 and the tap water 7.4. To check this theory 25 parts per million of acid sodium phosphate and 25 parts per million of basic sodium phosphate were added to two portions of distilled water, the former had a pH of 6.6 and the latter 7.6. Several samples of sewage were then diluted with the above two dilution waters as well as with plain distilled water and also the tap water.

It was found that the average difference of biochemical oxygen demand in the checks on four sewage samples was 45 parts per million with distilled dilution water with a pH of 6.6; 25 parts per million with plain distilled water pH 7.1; 7.5 parts per million with distilled water of 7.6 pH; and 5 parts per million with tap water. Although the average difference in the checks of the biochemical oxygen demand between the samples with distilled water of 7.6 pH and tap water was slight, the tap water gave an average biochemical oxygen demand of the four samples of 175 parts per million and the distilled water of 7.6 pH

Table I

Kind of Sewage	Distilled water	Tap water	Difference	Per cent distilled lower than tap
Average B. O. D. of 10 raw samples	172	214	42	24.4
Average B. O. D. of 10 tank effluent	145	180	35	24.1
B. O. D. of sprinkling filter effluent	72	78	6	8.3
B. O. D. of Secondary settling tank	80	84	4	5.0
B. O. D. creek water	10.4	12.5	2.5	24.0

was only 138 parts per million or a difference of 37 parts per million.

Finally another series was made up using all the information we already had in addition to making up several synthetic dilution waters containing sodium, potassium or calcium bicarbonate in quantities approximating the inorganic mineral content of the Trenton tap water. Seven samples of sewage were diluted in duplicate with each of the following five dilution waters:

(1) Distilled water containing 60 parts per million of Sodium bicarbonate pH 7.7.
(2) Distilled water containing 100 parts per million Calcium chloride pH 7.3.
(3) Distilled water containing 60 parts per million of Potassium bicarbonate pH 7.6.
(4) Distilled water with nothing added pH 7.1.
(5) Trenton tap water containing 75 parts per million. Inorganic salts pH 7.4.

The average difference of biochemical oxygen demand in the duplicate determinations with (1) was 4.3, (2) 8.0, (3) 4.3, (4) 5.0, and (5) 4.3 parts per million respectively.

The average biochemical oxygen demand of the seven sewages in duplicate was as follows:

(1) Distilled water and sodium bicarbonate	162
(2) Distilled water and calcium chloride	182
(3) Distilled water and potassium bicarbonate	186
(4) Distilled water plain	136
(5) Trenton tap water	192

From the above it will be seen that for the most consistent, uniform and also higher results the potash salt is superior to either sodium or calcium salts added to distilled water. It is also interesting to note the very much lower results obtained with plain distilled water than with distilled water to which any of the inorganic salts were added: 136 against 162 for sodium salts, 182 for calcium salts, 186 for potash salt, and 192 for Trenton tap water.

Conclusions.—No single factor alone that was tried in these experiments is responsible for obtaining maximum consistent results that will check, but a combination and close adherence to all factors, temperature of aeration, aging, temperature of incubation, mineralizing and pH are necessary.

Aged tap water of a good quality can be used satisfactorily for diluting purposes at any sewage plant, but when results are desired for the comparison of one effluent with another or many other effluents from various localities, it is advisable to use a uniform diluting water.

For a time it was thought that the nature of the material and the state of activity of the organisms associated with it was the principal factor in obtaining good results. This may still be a factor but is believed overcome or controlled by following the last series of tests.

The greatest factors for obtaining good results in biochemical oxygen demand determinations are: (a) mineralized water, preferably with potash salts, with a pH well on the alkaline side; (b) well aged diluting water; and (c) incubation at a uniform temperature and not below 20 deg. C.

Method Adopted by New Jersey.—In consequence of the above data the following method has been adopted as the tentative method for the determination of biochemical oxygen demand by the Bureau of Engineering, State Department of Health of New Jersey. This procedure gives a practical field method inasmuch as a supply of the aged synthetic dilution water is available in the laboratory.

Court Decisions Regarding Sewage Disposal

From Public Health Reports, July 5, 1929

Order of State Department of Health to City Relative to Sewage Disposal Upheld.—(Ohio Supreme Court; City of Bucyrus v. Department of Health of Ohio et al., 166 N. E. 370, 120 Ohio St. 426, 2 Ohio Bar 10; decided April 24, 1929.) The state department of health, acting under statutory authority and after complaint, investigation, notice, and hearing, ordered the city of Bucyrus to install works or means satisfactory to the state director of health for the collection and disposal of the sewage of the city in a manner to correct and prevent the pollution of the Sandusky River. In a proceeding in error from the department's order, the supreme court stated that all the questions raised were determined by its decision in the case of the State Board of Health v. City of Greenville, decided April 2, 1912, unless the adoption on September 3, 1912, of Article XVIII of the state constitution had so changed the relationship of municipalities to the state as to divest the state of its sovereignty over such municipalities in respect to sanitation within and in the vicinity of such municipalities. Said Article XVIII provided, in part:

> Municipalities shall have the authority to exercise all powers of local self-government and to adopt and enforce within their limits such local police, sanitary, and other similar regulations as are not in conflict with general laws.

The court's view was that the adoption of the article did not change the situation of the municipalities with respect to local sanitary regulations, except that before such adoption they had such power to adopt local sanitary regulations as had been conferred upon them by the legislature and since such adoption they had such power to adopt local sanitary regulations as had not been taken away from them by the legislature in the enactment of general laws. The court said:

> The effect of the constitutional provision granting to municipalities the power to adopt local sanitary regulations is, therefore, no different than though the power had been conferred by legislative enactment instead of constitutional provision; for, if conferred by legislative enactment, the act would be subject at all times to revision or repeal by the legislature. The constitutional provision conferring the power with the limitation that the municipal regulation must not be in conflict with general laws operates to bestow upon the legislature the same power to control sanitation by general laws that it had prior to the adoption of that article. The power conferred by that article is conditioned upon the legislature not having enacted general laws with which the local sanitary regulations of the municipality conflict.

The decision in the Greenville case was adhered to by the court.

With regard to the hearing before the health council, the court made the following observations:

> * * * While the technical rules of a hearing by a court are not required to be strictly observed in hearings before administrative bodies, it is the duty of such bodies to permit a full hearing before administrative bodies, it is the duty of such bodies to permit a full hearing upon all subjects pertinent to the issue, and to base their conclusion upon competent evidence; and such result can better be accomplished by a substantial adherence to the rules observed in hearings in court. In the instant case, the newspaper article was not competent evidence. * * * The reports of the engineers employed by the health department were official in character, authorized by statute, and were competent evidence in such hearing * * *. The city of Bucyrus was entitled to examine and to attempt to impeach such reports and each and every person who assisted in gathering data and compiling such reports. The city of Bucyrus was entitled to present its own witnesses to disprove any of the facts testified to by the witnesses of the complainants, or any of the facts shown in the reports, and was entitled to file such papers in the case as it deemed essential to the preservation of its rights and the preservation of its cause or defense, and was also entitled to make such defense without the filing of an answer. * * *

The department's order was affirmed.

Order of State Health Department Concerning Sewage Disposal Upheld.—(Ohio Supreme Court; State ex rel. Neal, Director of Health v. Williams, Mayor, et al., 166 N. E. 377, 120 Ohio St. 432, 2 Ohio Bar 10; decided April 24, 1929.) In a mandamus action to enforce the laws relating to the pollution of watercourses, the petition charged that the respondents were causing sewage of the city of Delphos to be discharged into certain streams, in violation of statutes, in such quantities and of such character as to pollute the streams, and that this conduct constituted a public nuisance by making the streams a menace to public health and welfare in the vicinity. The petition contained proper allegations necessary to show that, pursuant to complaints filed, an examination of the situation had been made by the state director of health; that a hearing, after due notice, had been held; that findings had been made and respondents notified thereof and directed to make other arrangements, within a specified time, for the proper disposal of sewage in a manner satisfactory to the state health authorities; and that the time fixed had elapsed and respondents had refused to comply with the order.

The respondents challenged the sufficiency of the petition and presented many other issues for the court's consideration, such as the unconstitutionality of the law under which the health department acted, misjoinder of parties, omission of parties, insufficiency of findings made by the health authorities, unreasonableness of the order, and also the claim that, under the home rule provisions of the constitution, the city could not be controlled by the state health department with respect to its disposal of the city's sewage.

The supreme court, which found against the city, said:

> This court is of the opinion that every issue presented by the pleadings and urged in the arguments and briefs of counsel has been fully and completely covered by the decisions of this court, and that there is now nothing further to be said on the subject.

Water Works and Sewerage

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Our New Title, "Water Works and Sewerage"

A year ago "Water Works" was merged with "Municipal and County Engineering" under the title "Municipal News and Water Works." For 12 years "Water Works" had specialized in the hydraulic field, and it has continued to devote nearly all its space to municipal hydraulics during the past year. This policy of hydraulic specialization is to be continued.

During the past year many of the old readers of "Municipal and County Engineering" have been induced to subscribe for "Roads and Streets," so that they now receive a semi-monthly municipal news service. Published about the first of the month, "Water Works and Sewerage" covers hydraulic and sanitary engineering features, while "Roads and Streets," which is published about the middle of the month, covers the pavement and street features of municipal engineering and contracting.

The third magazine of the Gillette Construction Group is "Engineering and Contracting" which was founded 24 years ago next January by Myron C. Clark and Halbert P. Gillette. This magazine covers bridges, buildings and heavy construction such as railways, irrigation canals, etc. The three magazines together give complete coverage of the civil engineering field and its allied contracting.

Municipal hydraulics, to which "Water Works and Sewerage" is devoted, embraces the allied fields of city water supply and sewage treatment and disposal. It costs about $80 per capita to build a modern water works system and almost an equal sum to build a sewerage system. Since nearly 75 per cent of our people live in incorporated towns and cities, we have about 90,000,000 urban residents. To reproduce their water works and sewers would cost not much less than $1,400,000,000; it would cost fully that if they were all adequately served. Most of the smaller towns have inadequate hydraulic plants and service. The same is true of many of the large cities. Inadequacy of plant is seen wherever water meters are not installed, which unfortunately is the case in all too many instances. The same is true where hard water is not softened, where impure water is not chlorinated and where raw sewage is discharged into streams from which other towns and cities take their water.

There is a vast deal yet to be done by American engineers, superintendents and contractors before our systems of municipal water supply and sewage disposal may be regarded as being satisfactory, either from an economic or from a sanitary point of view.

This magazine was the first American magazine to specialize completely in municipal hydraulics. It is the only magazine devoted solely to water works and sewers. Last June its first Water Works and Sewerage Catalog issue was published, and distributed at the time of the annual convention of the American Water Works Association. Our readers will receive an even larger and more complete book of hydraulic reference data next June.

Predicting Storms by Static

Nearly 180 years ago Benjamin Franklin flew the famous kite whose string brought to earth an electric current from a cloud. He believed that the friction of the air electrified the clouds, and to this day that theory, with a few additions, is generally accepted. It is now believed that the disruption of rain drops also generates electric charges, and that charges so generated may be even more potent than charges produced by friction.

The editor believes this theory to be wrong. Instead of electricity being generated by the clouds, the editor believes that electricity generates the clouds, for he regards all cyclonic air-whirls as electromagnets whose free electrons are rotated by the earth's magnetic fields. Since our storms are all cyclonic, it follows that storms should invariably show electric effects. That this is at least the usual case is indicated by the static that has been found to be caused by many storms.

A. H. Harper, of the research department of the American Telephone and Telegraph Co., recently announced that by aid of two loop aerials connected to radio sets, he has been able to locate the position and trace the track of many storms. For example, a storm center was located northwest of the Great Lakes, Sept. 7, 1928; and six days later it passed near Houlton, Maine, accompanied by lightning. We predict that this radio method of discovering storm centers and tracing their tracks is destined to revolutionize the prediction of storms.

In several articles the editor has given his electromagnetic theory of air-whirls, but it will be very briefly outlined again.

Air contains free electrons. Free electrons tend to rotate around the lines of force of a magnet. The earth is a compound magnet. So is the air above it. Free electrons moving in the same direction in approximately parallel orbits constitute an electromagnet. Hence air, if sufficiently charged with free electrons, is given a whirl. When thus whirling the air-whirl is itself an electromagnet. Since parallel electric currents in the same direction attract one another, the electrons tend to become concentrated in a belt around the whirl center. Hence air flows from the center as well as from the outside toward the whirl belt. Since opposite electric currents repel one another, the whirl-belt expands to a position of equilibrium. The net effect is low barometer near the center of the whirl-belt, but it is not this "law" that causes the air to ascend. Electromagnetic force pushes a cyclonic whirl-belt upward. The air is literally pumped upward by electromagnetic force. The rising air is cooled and tends to precipitate some of its moisture. Electrons act as centers upon which the moisture collects. Clouds form. When the

electromotive force becomes high, relative to the resistance, discharges occur. Moisture in the air is favorable to such discharges. So is great altitude, for as the pressure is reduced more electrons are set free.

Every statement in this last paragraph is founded upon electric theory established by experiment, yet, strangely enough, this theory of storms had not been suggested by any meteorologists and is still regarded with skepticism. Static electric theories had previously been suggested to explain ascending air currents, but they could not account for the magnitude of the barometric changes, and they made no attempt to explain the rotary nature of storms. On the other hand, the editor's electromagnetic theory accounts for every important feature of storms, such as: (1) Rotation, (2) ascent, (3) progression, (4) the subsequent "high" (anticyclonic), (5) electric charge, (6) inflow of the outer air, (7) low barometer at the center, (8) opposite rotation in the northern and southern hemispheres, (9) storm effects of sunspots (which are themselves electromagnets), and (10) the two stormy seasons that center around January and July when the axes of the earth and sun are in the same plane.

In addition to the ten features just named, there are many others that are explained by the electromagnetic theory, and without the aid of any other new theory. Also, although this theory is new, it rests upon facts established by laboratory experiments. None the less it will find "slow sledding," for old theories, however inadequate or incorrect, have the vitality of a cat with its nine lives raised to the ninth power.

The Need of a Large Research Staff in Our Weather Bureau

When our government follows the example of our great corporations and organizes a large research staff to investigate the causes of weather changes, we may hope for satisfactory progress in the art of weather forecasting. It will be replied by the Weather Bureau that much progress has been made, and that they are conducting researches; but the fact remains that although that bureau has been in existence nearly 60 years, it confesses inability to forecast weather much more than a week in advance.

A few years ago, Prof. Cleveland Abbe, then editor of the "Monthly Weather Review" (the government magazine) wrote the article on meteorology that was published in the Encyclopedia Britannica. Speaking of the influence of sunspots and other cosmical forces on weather, he said: "But, in the writer's judgment, these matters, while curious and interesting, have no appreciable bearing on the current important questions of atmospheric mechanics. . . . The leading meteorologists have relegated such questions to the care of theoretical astronomers and physicists until our knowledge is more firmly established." And he goes on to add that "it would be folly to spend time" on a study of cosmical causes of weather until a better knowledge is attained of the earthly causes which present such a "bewildering maze of problems." Thus, while admitting the existence of a "bewildering maze" he calls it folly to seek extrication from that maze by study of sunspot effects and the like!

That Prof. Abbe's spirit still is potent in our Weather Bureau was recently made clear to the writer when the editor of the Monthly Weather Review declined even to look at a manuscript that an hydraulic engineer offered to submit on the relation of sunspots to rainfall. That editor was so cocksure that no one could possibly discover any new and important relationship between sunspots and weather that he would not even spend a few minutes of his time reading the manuscript.

Not many months ago Prof. C. F. Marion, chief of the Weather Bureau, gave an interview to the newspapers in which he held up to ridicule all attempts at long distance weather forecasting. He was quoted as saying: "When long distance weather forecasting is on a scientific basis, rather than a foundation of mere guesswork, such forecasts will be made by the weather bureau." So, with "admirable scientific caution," he patiently waits, as his predecessors have waited for 58 years, for someone to show them how to make long distance forecasts. But his is like the adamantine mug of the man in the show window: "Make him smile and we will pay you $10." He dares anyone to change his expression of indifference or the belief that engenders it.

Meteorologists, according to Prof. Abbe, should wait for astronomers to pave a definite relationship between sunspots and weather. Well, Prof. Douglass (an astronomer) did that very thing nearly a generation ago, and so did Prof. Huntington (a geographer), and so did Prof. DeGeer (a geologist), but Prof. Marvin (the meteorologist) is still waiting. The clues that such scientists have furnished have not been diligently followed up by the Weather Bureau. It refuses to "smile," because it is resolved not to "smile." Small wonder that Father Ricard, the Jesuit astronomer and meteorologist, recently said that the heads of the Weather Bureau are suffering from "sleeping sickness."

So far as farmers and hydraulic engineers are concerned—and we are now speaking in behalf of the latter—the Weather Bureau has failed to make any progress in solving the important problem of long-distance weather forecasting. We venture to say that in a year's time a committee of hydraulic engineers would make more progress in solving this problem than the Weather Bureau has made in the 58 years since it was founded.

We do not wish to be understood as condemning what the Weather Bureau has done, but what it has failed to do. Its "Monthly Weather Review" is a valuable magazine. If it had never done more than recently to translate and reprint Prof. Fritz's old (1893) article on "The Periods of Solar and Terrestrial Phenomena" (M. W. R., October, 1928), it would have justified all the money spent in publishing the magazine since its inception. The same is true of Homer W. Clough's recent article (M. W. R., July, 1928) on the 28-mo. solar and weather cycle. Mr. Clough, we believe, is one of the Weather Bureau staff. What we urge is the organization of a large staff of competent researchers whose sole function shall be to try to fathom all the mysteries of weather phenomena. Such a staff would welcome aid from every source, looking, as it would, with friendly eye upon any suggestion, however fanciful it might seem, and enlisting the aid of men in every branch of pure and applied science. The trained researcher is never skeptical. On the contrary, he knows that from the most fantastical hypotheses the greatest discoveries have so often sprung, that he bids every Columbus "God-speed."

H. P. Gillette

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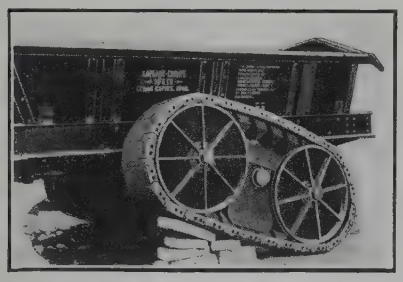
La Plant-Choate Manufacturing Co., Cedar Rapids, Ia., have placed on the market a wagon track that is a big step ahead in their line of equipment. These



La Plant-Choate Crawler Wagon

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Witte Produces Newly Designed Engine Powered Diaphragm Pumps

For jobs where accumulations of muddy, trashy water must be pumped, two specially designed, heavy-duty, engine-powered diaphragm pumpers are now offered to the construction and engineering field by the Witte Engine Works, Kansas City, Mo.

Each of these pumpers is a complete portable unit, direct, single reduction, gear-drive engine, pump and transmission being compactly and rigidly mounted on a rugged, all-steel truck. Capacities, per hour are, it is claimed, for the one outfit (No. 10), up to 5,000 gallons per hour, and for the other (No. 12 outfit with two intakes for working in one or two excavations at the same time), up to 10,000 gallons. Pumps are self-priming, and can be furnished with flexible hose and foot valve to water connection.

All bearings on engines, pumps and transmissions have compression grease cup lubrication. The engine crank case is enclosed, thus protecting moving parts from all dirt and sand. Gears are steel alloy and machine cut. Pump valves are wing-guided poppet type and have replaceable rubber facings. Valve seats are carefully machined. Lever-arm bearings have replaceable bronze bushings.

Reliable, low-cost power is provided by the all-fuel Witte throttling governor type "H" engine, WICO magneto ignition, weather and water proof. For general power use, the engine is quickly detachable from the pump, and drive pulleys can be put on the extended crank shaft on both sides.

The pumps are now available through the regular trade channels, as also are the various sizes and types of internal combustion engines which the Witte Company has developed in its half-century of exclusive engine manufacturing. The line now embraces units of 2, 3, 4, 6, 8 and 12 hp., and a special heavy-duty type in 20 and 30 hp. sizes, including power deep well and pressure pumps and power saws.

High-Pressure Double-Deck Compound Turbine-Generator

Several unusual or new features will be incorporated in two steam turbine generators which are to be added to the generating facilities of the Pacific Gas & Electric Co., San Francisco. The two machines, each rated at 50,000 kilowatts, will be the first of the new "double-deck compound" type, and will be fueled with natural gas piped from a source 240 miles away.

It is claimed the station will be one of the most efficient in the world, the result both of employing 1,250-lb. boilers and using natural gas as fuel. Each main 1,200-lb. turbine unit, of General Electric manufacture, consists of a high-pressure element operating at 3,600 r.p.m. and a low-pressure element operating at 1,800 r.p.m. The turbines, rated at 50,000 kilowatts each, are to be suitable for a maximum output of 62,000 kilowatts. Provision is made so that the low-pressure turbine can be operated from the high-pressure boilers with the high-pressure turbine shut down.

A new type of construction will be used, in that the high-pressure turbine and generator will be mounted on top of the low-pressure generator, thereby saving the foundation and the floor space ordinarily required for the high-pressure turbine. The result is a very compact unit.

In addition to the main turbines, two General Electric auxiliary turbines are included for driving the boiler feed pumps. These pumps, used with high-pressure boilers, absorb considerable energy, and therefore these turbines are much larger than usual. They are of the two-unit type, composed of condensing and non-condensing elements. The condensing element is coupled to one end of the pump and takes steam from the present 300-lb. boilers; the non-condensing element is coupled to the other end of the pump and takes steam from the cross-over between the main turbines. This arrangement permits the two elements of the turbines to be operated at times independently and at other times together, so as to maintain at all loads the most economical heat balance on the installation as a whole.

Lincoln New Kathode Welding Electrode

Extensive research and experimentation by the Lincoln research laboratories has made possible the offering to the trade of the New Kathode welding electrode by The Lincoln Electric Company, Cleveland, O. The electrode is manufactured for the arc welding of mild steel and for cast iron repair work.

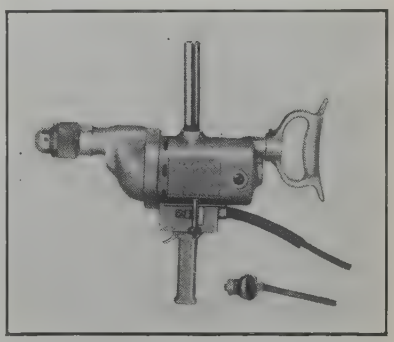
The composition of the New Kathode welding electrode, as well as the special treatment given in its manufacture, imparts qualities heretofore lacking in the usual electrode. Flowing easily with freedom from sputtering, the new electrode produces clean welds with minimum slag and oxidation. The high heat permissible for use with this fast running electrode makes possible increased welding speed. The quality of the weld is not sacrificed for speed of welding, as the New Kathode electrode fuses easily. The resulting weld on steel is soft and readily machinable.

The New Kathode electrode is manufactured in stock lengths of 14 and 24 inches. To provide best possible protection, during shipment, the rod is packed in metal containers holding 50 pounds each.

New "Wodack" All Purpose Drill

The new Wodack all purpose portable electric drill, made by the Wodack Electric Tool Corporation, 4627 West Huron street, Chicago, combines lightness with power and performs in an unlimited range of drilling requirements.

A General Electric motor of ample reserve power is built in for direct or alternating current of 60 cycles or less, 110-125 or 220-250 volts as desired. An oversize double pole, trigger switch in convenient position, insures long life. High grade ball and roller bear-

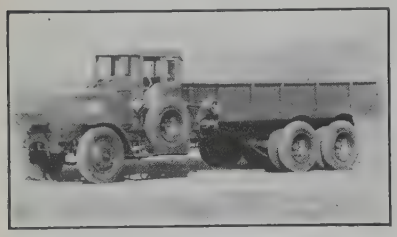


The New WODAK All Purpose Drill

ings are used, the heavy thrust loads being carried by Timken roller bearings. Hardened gears are simply assembled, grease compartments are designed for long periods of operation, and correct ventilation is provided for by an oversize fan for quick cooling during idle running.

New Mack Super-Duty Truck

Modern highway transportation requires speed either as a competitive element in the business of hauling or as the transportation element where it is one of the distribution or manufacturing processes in other industries.



Mack's New 6-Cylinder Super-Duty Truck

The road speed necessary to meet the demands for rapid delivery service has, heretofore, been obtained by reducing load capacities, using pneumatic tires and higher gear ratios with existing engines. This reduced the most essential element of hauling economy, which is capacity.

Mack now introduces the Super-Duty line of trucks, two models of which are designed to carry great loads at high speed.

The AP 4-wheeler and the AP 6-wheeler will carry from 7½ to 10 ton truck loads at 30 miles per hour and climb 20 per cent grades with ease provided the footing is given. They will haul 35 ton drawbar loads at 25 miles per hour. These massive AP trucks are powered by 6-cylinder high compression engines of 150 horsepower.

When 70,000 pounds or 35 tons can be hauled with one engine and one driver at a steady speed of 25 miles per hour, the tremendous possibilities in low cost transportation is evident.

Twenty-five miles per hour will generally equal the average speed of lighter vehicles so that the service element of speed is combined in the Mack Super-Duty line with the economy of great capacity.

In addition to the AP model, the Super-Duty line includes the famous AC model with a new high compression engine and six wheels. This Super-Duty vehicle is designed, not for speed, but for hauling heavier loads under the difficult conditions encountered in the earth moving industry and other fields where the greater traction and better load distribution of six wheelers is recognized.

The most outstanding innovation, in addition to the tremendous power in the model AP, is the six-wheel feature with rear, four-wheel drive. In this, Mack has retained its characteristic heavy duty feature—chain drive.

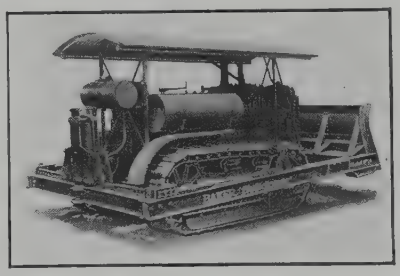
The rear truck consists of two dead axles mounted through rubber shock insulators to massive spring tips. The spring is anchored at its base to a horizontal torque bar mounted in the frame so that the load is equally distributed between the two rear axles. This distribution which is the most desirable from a standpoint of road impact, can be obtained on the Mack Super-Duty models because the tractive resistance of all four wheels is effective through four-wheel drive.

The drive is effected by means of four sets of driving chains, each set of rear wheels driven by an independent jackshaft. Brakes are on all rear wheels as well.

Baker Bulldozer Announced

The Baker Mfg. Company, Springfield, Ill., has just developed the Baker hydraulic bulldozers for 30 and 60 Caterpillar tractors.

The frame of the bulldozer surrounds the tractor, mounted and pivoted at the rear of the tractor draw bar and on outer ends of the rear axle of the tractor. The pull is thus at three points in a straight line with even distribution of power. Heavy and rigid construction of both moldboard and frame give the bulldozer exceptional strength.



Bulldozer Developed by Baker Mfg. Co.

The raising and lowering of the blade is accomplished by means of an oil-operated gear pump, directly connected to the power drive shaft of the tractor, which operates a hydraulic ram. Mounted forward of the center of the truck frame on each side is a heavy steel bracket clamped to the truck frame of the tractor. At the top of each bracket is a roller chain which operates over a cast steel sprocket mounted in suitable bearings on the side of the frame. As the roller chain is connected to the hydraulic ram at the rear, the vertical action of the ram lifts the moldboard off the ground to the required height.

A hand lever conveniently located near the tractor operator's seat controls the raising and lowering of the blade.

The particular advantages claimed for the Baker bulldozers are: (1) Ability to operate various distances below the level of the track of the tractor, (2) Higher elevation of the blade, (3) Keeping a more nearly level grade, (4) Strength and (5) Easier operation.

Hyatt Develops New Bearing

To satisfy an increasing demand for a roller bearing interchangeable with standard S. A. E. single row ball bearings, but having greater load capacity, the Hyatt Roller Bearing Company of Newark, N. J., are now manufacturing single row radial bearings.

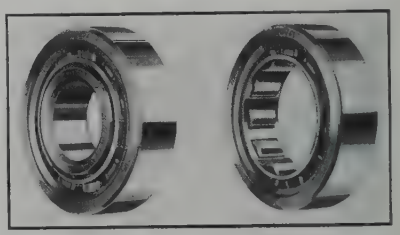
This new line of Hyatt single row radial bearings, made up of solid rollers, is not intended to replace the standard Hyatt roller bearing which uses spirally wound rollers, but is offered as a supplement to it, for positions in which space limitations exist, and loads beyond the capacity of ball bearings must be sustained.

The design employed is one in which the rollers are permanently retained with the outer race, the inner race being separable.

A separator, floating on the rollers, spaces them properly, and heat treated end rings retain them endwise within the outer race. The end rings and separator function to keep the rollers in proper alignment insuring positive contact along their full length. This full line contact of the rollers, the Hyatt Company states, enables their single row radial bearings to sustain greater loads than can safely be carried by ball bearings of equivalent sizes which have only spot or point contact between balls and races.

The manufacturer states that the rollers and races of this bearing are made of a special analysis chrome nickel alloy steel, and the end rings are of vanadium steel to eliminate any wear by the ends of the rollers. The roller separator is so made that the pockets are absolutely parallel and equally spaced, thus assuring uniform load distribution on the rollers.

It is further stated that the possible separation of this bearing into two parts, the inner race being removable, offers opportunities of developing more economical methods of assembling for all applications with or without the inner race. The roller ends are sufficiently rounded to facilitate assembly where the inner race is not used and both the outer and inner races are chamfered at one end.



The Hyatt Single Row Radial Bearing With the Inner Race and With the Inner Race Removed to Show Roller Construction

Hyatt single row radial bearings are now in regular production in a range of sizes sufficient to cover the needs of the present for this type of bearing.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Clark Operates Model Foundry
Interior View of the Iron Foundry Operated by H. W. Clark, Mattoon, Ill., Manufacturers of Clark Water Works Necessities. This Is One of the Most Complete and Up-to-Date Gray Iron Foundries in the Middle West. The Building Is of Special Design to Accommodate the Travelling Crane Equipment, and Laid Out for Economical and Efficient Production. Nothing Is Done by Hand That Can Be Done by Automatic Machines from the Preparation of the Sand to the Ramming or "Squeezing" of Patterns in the Flask. The Cupola Capacity Is Twenty-four Tons a Day.

General Electric Holds Board Meeting on Electric Yacht

A recent meeting of the board of directors of the General Electric Company was held abroad the "Viking," a new 263-foot electric yacht owned by George F. Baker, Jr. The yacht was boarded at 26th Street and East River and cruised along Long Island Sound.

At the meeting announcement was made of the retirement of Allen H. Jackson, who has been general counsel and vice-president of the company since 1922. Mr. Darius E. Peck was elected to fill the position left vacant by Mr. Jackson's resignation, and the president of the company, Mr. Gerard Swope, stated the company would still be able to call upon Mr. Jackson in matters requiring consultation.

Mr. Peck, the newly elected vice-president, is a graduate of Yale University, and practiced law in New York City from 1902 until 1921, when he became a member of the law department of General Electric Company and moved to Schenectady.

The retiring vice-president, Mr. Jackson, joined the General Electric Company in 1902, as one of its attorneys. In 1922, the year in which Gerard Swope succeeded E. W. Rice, Jr., as president of the company and Owen D. Young succeeded the late Charles A. Coffin as chairman of the board, Mr. Jackson was appointed vice-president and general counsel.

The yacht on which the directors met, was electrified by the General Electric Company and exemplifies the first pleasure craft to be equipped with turbine electric propulsion, according to statement of one of the company's officials. The yacht was designed by Theodore D. Wells and built by the New Port News Shipbuilding and Drydock Company. It is of twin-screw type, each propeller being driven by a 1,300 shaft-horsepower motor from electric power supplied by two turbine generators. All auxiliaries are electrically operated.

The Wagner Electric Corporation of St. Louis, Mo., has moved its Cleveland service station and branch sales office to a new building at 3756 Carnegie Ave. The Cleveland office handles the entire Wagner line of motors, transformers, fans and Lockheed Hydraulic brakes, not only as a branch sales office, but also as a repair shop and service station.

North Western Buys Graver Softeners

The Chicago and North Western Railway Co. has contracted with Graver Corp., East Chicago, Ind., for three complete Graver Water Softening plants. The sizes and locations of these plants are: Clyman Jct., Wis., 20,000 gal. per hour, with additional storage for 60,000 gal. South Janesville, Wis., 15,000 gal. per hour, with additional storage for 35,000 gal. Jefferson Jct., Wis., 12,500 gal. per hour, with additional storage for 50,000 gal.

All of these plants will be equipped with the new Graver chemical control equipment, brought out within the past year. The Graver control mechanism consists primarily of a standard commercial water meter installed in the inlet line to the softener. This meter is attached to the feed pipe in the chemical tank and allows the chemicals to flow into the softener in direct proportion to the water.

The North Western has also contracted with Graver Corporation for an additional tank 21 ft. dia. x 52 ft. high to enlarge the capacity of the Graver Softener installed at Boone, Ia., several years ago.

Continental Motors an Exhibitor at Aeronautics Exposition

C. P. Russell, aeronautical sales manager for the Continental Motors Corporation of Muskegon, Mich., together with F. T. Gould, was in charge of Model A70 160 hp. radial engine and component parts at the Aeronautical Exposition held in Cleveland recently in conjunction with the National Air Races.

At the time this item went to press it was announced that the Continental powered plane would make a number of trips between Cleveland and Detroit during the races to transport members of the aeronautical division to Cleveland.

Bendix Aviation Takes on New Subsidiary

The East Orange plant of the Eclipse Machine Company has been taken over as a subsidiary unit of the Bendix Aviation Corporation and is to be known as the Eclipse Aviation Corporation.

This plant will continue to produce a complete line of starters for aircraft, as well as other aircraft equipment and aeronautical devices now being developed.

Schwanhausser Goes to Buffalo as Manager for Worthington

Mr. E. J. Schwanhausser, who entered the employ of the Worthington Pump and Machinery Corporation while a student at Stevens Institute of Technology, has just been appointed manager of that company's Buffalo works. Mr. Schwanhausser is but 35 years of age, and is one of the youngest executives in the Worthington organization.

E. J. Schwanhausser, Recently Made Manager Buffalo Works for Worthington Pump and Machinery Corporation

During the summers of 1912, 1913 and 1914, while still in school, he was employed in the various shops and on the testing floors at Harrison, and immediately upon his graduation in 1915, he was made test and erection engineer. He served successively in the condenser engineering department, as machine shop equipment engineer, superintendent of the machine shops, superintendent of field erection department and assistant to the manager.

In 1927 Mr. Schwanhausser was appointed assistant works manager, and it was while holding this position that he was made manager of the Buffalo works.

General Electric Distributing Companies Consolidate

Effective Oct. 1, 1929, the fourteen wholesale distributing corporations owned by the General Electric Company will be consolidated into the General Electric Supply Corporation (of Delaware), according to recent announcement. These companies have for many years distributed General Electric products and the plan, it is said, involves no change of ownership. The consolidated corporation will be in a much better position to offer nation-wide service through its ability to give service from any one of seventy-six houses, through interchangeability of stocks, and speedier and more economical operation.

The tentative organization plans indicate corporate officers and directors as follows:

Gerard Swope, chairman of board; C. E. Patterson, president and director; J. L. Buchanan, executive vice-president and director; J. G. Johannesen, vice-president, eastern region, and director; D. E. Harris, vice-president, western region, and director; N. R. Birge, A. D. Cameron, H. C. Houck, J. E. Kewley, G. C. Osborn, T. K. Quinn, E. O. Shreve, C. E. Wilson, directors; L. R. Link, secretary-treasurer; L. M. Nichols, comptroller.

Gardner-Denver Representatives Sent Far Afield

Two foreign branch managers of the Gardner-Denver Co. left the United States this week to take charge of their respective offices.

Ralph Scott, formerly sales manager of the drill division of the company, is enroute to London where he is to be stationed permanently. W. G. Agnew, who was until recently the Gardner-Denver sales representative in Arizona, leaves for Lima, Peru, to take charge of the office there.

The Gardner-Denver Co. manufactures rock drills, air compressors, slush pumps, drill sharpeners, high pressure drill steel forges and kindred machinery. Its main plants are located in Denver, Colo., Quincy, Ill., and La Grange, Mo.

Harold Smith Becomes Vice-President of Westinghouse

At a recent meeting of the board of directors of the Westinghouse Electric and Manufacturing Company, Mr. Harold Smith, general solicitor of the company, was elected vice-president.

Mr. Smith entered the legal department of Westinghouse in 1919, becoming general solicitor in 1926. Prior to that time he was engaged in the practice of law in Chicago, where he was a member of the firm of Glennon, Cary and Walker. He is a member of the state bars of New York and Illinois, and holds law degrees from Northwestern and Yale Universities.

His office will be in the Westinghouse Building, 150 Broadway, New York.

W. A. Gluesing Will Handle General Electric Booth at Petroleum Exposition

Arc welding and atomic hydrogen welding sets will be shown in operation, as well as motors and control for drilling, pumping and refining together with an educational exhibit from the General Electric laboratories will be on display at the International Petroleum Exposition to be held in Tulsa, Okla., early in October.

"Casey Jones," the toy train which obeys commands transmitted to it through the medium of an ordinary telephone transmitter, will be included in the exhibit which is under the direction of Mr. W. A. Gluesing for the General Electric Company of Schenectady, N. Y.

Riddell Company to Hold Pow Wow

A very enticing looking invitation has been sent out by W. A. Riddell Company for a three-day conference to be held in Bucyrus, Ohio. It is expected that there will be a large attendance made up of the sales organizations throughout the country representing Riddell. The meeting will be held at the Elks Club, Sept. 16, 17 and 18.

In addition to inspecting and watching demonstrations of the new machines and improvements which are to be announced to the trade at the Road Show in Atlantic City in January, it appears from the invitation that golf courses, fishing grounds, baseball fields, and even the lowly horse shoe will come in for due consideration.

The next issue will tell about results accomplished.

Appointed Sales Manager

W. H. Arnold has recently been appointed general sales manager for the Pittsburgh Valve, Foundry & Construction Company, making the fourth man to hold that position since 1900, when the constituent companies of Pittsburgh Valve were incorporated.

Mr. Arnold has been connected with the Pittsburgh company since 1905, and during his first twelve years acquired a thorough and comprehensive knowledge of the valve and piping business through working in the various departments of the plant.

Since 1917 he has been engaged in sales activity, bringing to the merchandising field all his knowledge of the products gained when identified with their manufacture. He is almost universally known not only among the power, industrial and oil interests of the East, but equally as well among the gas and oil interests of the mid-continent.

Thomas W. Hall Joins Fairbanks-Morse Co.

Announcement has been made to the effect that Mr. Thomas W. Hall, an engineer with a broad background of industrial experience and editorial work, has joined the staff of the Fairbanks-Morse organization. Mr. Hall will handle the type of work formerly under the direction of Mr. R. H. Bacon.

Mr. Bacon has been made manager of advertising for the company, and the nature of his new position will make it necessary for him to give up the editorial contacts which he has maintained for so many years with technical publications.

C. & O. Buys Large Softening Tank

The Chesapeake & Ohio Railroad has contracted with **Graver Corporation**, East Chicago, Ind., for a settling tank for a softening plant to be built at Boston, Ind. This tank is 40 ft. in diameter by 43 ft. high and has a downtake 12 ft. in diameter.

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for Northern California territory. Now stocking equipment for several well known machinery manufacturers.

Manufacturers' agents representing well-known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and Western Nevada territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Civil engineer located in Porto Rico would like to hear from manufacturers desiring sole representation for their products in Porto Rico, Santo Domingo and Venezuela. Machinery for highway construction, purification plants, steel for buildings or bridges or other building materials and contractors' equipment.

Sales representative desires business connection with manufacturer of snow plows and road machinery for Minnesota and Northwest territory.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

Manufacturer of water works brass goods, would like to make proposition to manufacturers' representatives calling on waterworks trade.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the Southwest and Middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Manufacturer of complete line of Construction Equipment, mixers, saw rigs, plaster and mortar mixers and pumps, has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of rotary pump, especially designed for road construction work, has proposition for reliable distribution houses.

European Engineers Will Witness Lincoln Automatic Welding Demonstration

Mr. J. F. Lincoln, president of The Lincoln Electric Company, recently sailed on the Leviathan for London, England, where he will take charge of a demonstration for European engineers of the Electronic Tornado process of carbon arc welding which, since its inception, has revolutionized the method of automatic welding in this country.

The demonstration will take place at The Allen Liversidge plant. It is stated the demonstration has been arranged in answer to numerous requests from enginers and manufacturers in all parts of Europe.

Diesel Engine Manufacturers Organize Association

With the rapid growth in the use of Diesel engines in all types of industrial, public utility and municipal service, as well as in the railway, automotive and marine fields, the manufacturers of Diesel engines have realized the need for a closer contact with each other and with the problems of the user. As a result, twelve of the leading builders, representing practically the entire output of Diesel engines in the United States, have organized the Diesel Engine Manufacturers' Association. The association has as its primary object, the advancement of Diesel power in America and a broad program of cooperation with the users of this type of power.

Possibly the greatest benefit to the users of Diesel power will come through the development of suitable standards of manufacturing and engineering practice. Such active problems as specifications for oil fuels, wider distribution of accepted fuels and similar subjects will have the attention of the manufacturers.

It is also the intention to promote and extend the use of Diesel power. In accomplishing this object, more information will be made available on the application of Diesel engines in all types of service. In this connection the association anticipates the helpful cooperation of the technical, trade and business press of the country in presenting the story of what Diesel power is accomplishing all through the broad range of industry.

During the past few years there has been much definite progress in Diesel engine design. The manufacturers feel that the next most important step is to take greater advantage of the economies of Diesel engines in all types of application work. In the struggle to reduce production costs in all lines of manufacturing, power cost plays such an important part that the Diesel engine is effecting marked savings. In the field of power distribution, represented by the public utility organizations, there is now a definite trend towards the use of Diesel power. In this field it is expected that the Diesel engine will play an increasingly important part as the years go by.

In marine service more than half of the tonnage now being built is equipped with Diesel engines and in the work boat field practically no other type of power is being used. The first airplanes equipped with Diesel engines have recently completed very satisfactory test flights and a number of automobile buses and trucks are being driven with this form of power.

Although Dr. Rudolph Diesel, a German engineer, is commonly given credit for the invention of the engine which bears his name, the first commercial installation was in the United States in 1893. Not much progress was made from that time until about 1912 when a number of improvements again focused attention on this type of power. The progress since that time has been rapid until today more than 4,500,000 horsepower of these engines are in marine and stationary service. Of this total, some 3,000,000 horsepower is in the United States.

In addition to its low operating cost the Diesel engine has the interesting characteristic of being just as efficient in small sizes as in large units. The largest engine to date is 15,000 hp. and is installed in a German power station. Units of 5,000 to 8,000 horsepower are becoming quite common in the marine field. It makes little difference, however, whether the engine is 50 or 10,000 horsepower, it has the same high efficiency.

Because of the simplicity of the Diesel engine with its elimination of any kind of ignition system or carburetors, it has established some remarkable reliability records. Any number of instances have been recorded where Diesel engines have operated continuously for more than a year without a single shut down. Practically all of the first Diesel engines installed in the United States, some twenty-five years ago, are still in operation.

In addition to encouraging the wider use of this efficient prime mover the manufacturers are also giving more attention to better Diesel power plant design. Although the Diesel engine is a very simple type of prime mover its satisfactory operation depends on good plant layout. Cooling water and lubrication are especially important in this field and the layout of cooling water systems has come in for considerable study. The use of lubricating oil purifiers of various types and the development of completely automatic lubrication systems have eliminated difficulties in this phase of plant operation.

With all of this increasing interest in Diesel engines, the manufacturers through their Diesel Engine Manufacturers' Association, are filling an important need in making all sorts of information available to the public with respect to Diesel engines and their operation.

The following manufacturers are members of the association:

New London Ship & Engine Works, Electric Boat Co., Worthington Pump & Machinery Corp., Fulton Iron Works Co., Ingersoll-Rand Co., Fairbanks, Morse & Co., Nordberg Manufacturing Co., I. P. Morris & DeLaVergne, Inc., Winton Engine Co., Cooper-Bessemer Corp., McIntosh & Seymour Corp., Busch-Sulzer Bros. Diesel Engine Co., Hooven, Owens, Rentschler Co.

The president of the association is Henry R. Sutphen, president, Electric Boat Co.; E. T. Fishwick, vice-president of the Worthington Pump & Machinery Corp., is vice-president of the association; and Harlan A. Pratt, manager oil and gas engine department of Ingersoll-Rand Co., is secretary and treasurer. The association also employes M. J. Reed as research engineer, with headquarters at the association office, 30 Church St., New York City.

Bay City Shovels Expects New Offices to Be Ready for Occupancy in October

Bay City Shovels, Inc., of Bay City, Michigan, is looking forward to occupying early in October the new office building which is now in the course of construction under the direction of the Henry C. Weber Construction Company. The new building is being located on the Shovel Company property adjoining the factory and is of modern fireproof construction, reinforced concrete foundations and floors with hollow clay tile and face brick walls. The top floor will be occupied by the drafting room and engineering department, as well as an auditorium, and each floor will be provided with a fireproof storage vault.

The construction of the new office building is following out a previously announced expansion program, the first step of which is now completed in the new fireproof factory building equipped with an electric overhead traveling crane and containing 18,000 sq. ft. of floor space available for the assembly department. Mr. Morgan Ramsay, one of the officials of the company, states that the increased facilities were made necessary to meet the demand for the Bay City power shovels, and the machine shop division is now operating in day and night shifts.

Chicago Pump Company announces that Sprekelmeyer-McDonald Company, 709 Pennsylvania Avenue, Ft. Worth, Tex., has been placed in charge of that territory.

I. F. Baker to Direct Foreign Sales for Westinghouse

Mr. I. F. Baker, who has served the interests of the Westinghouse Electric and Manufacturing Company in many capacities since his apprentice days in 1909, has recently been appointed European sales manager of the Westinghouse Electric International Company and will be located at No. 2 Norfolk Street, Strand, London.

In 1913 Mr. Baker was transferred from the industrial sales department to the Westinghouse Export Company at East Pittsburgh, and in 1918 was transferred to the New York office of Westinghouse International, only to be sent the following year to Japan. While in Japan he became prominent in commercial and engineering affairs, serving as president of the American Merchants' Association of Tokyo and acting president of the American Association of Tokyo.

Just previous to Mr. Baker's appointment to the post in England, he had been power division sales manager of the Westinghouse Electric International Company, with offices in New York. It is said that Mr. Baker's efforts while in Japan contributed largely to the installation of one and a quarter million kv-a. of rotating apparatus, and two and a quarter million kv-a. of transformer equipment.

Universal Power Shovel Factory Moved to Milwaukee

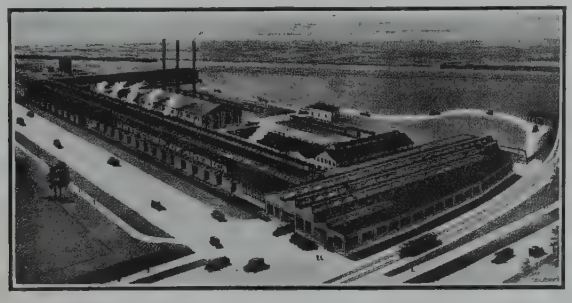
Announcement has recently been made of the removal of the factory and personnel of the Universal Power Shovel Company from Detroit to Milwaukee.

This company, which has been manufacturing excavating and material handling equipment for several years, was acquired a few months ago by the Unit Corporation of America, and since that time increased sales have made necessary better production facilities.

The new factory, located at Milwaukee, Wis., has just been completed. It is expected that the ample floor space and new, modern machinery will adequately meet the requirements of the company. Straight line assembly operations have been installed, and scientific production methods have been applied to the manufacture of the new line of gasoline power shovels, cranes, clamshells, draglines and backfillers.

Orders for machines and service parts are assured prompt handling because of the convenience of the plant's location for incoming and outgoing freight.

Headquarters in the new Bankers' Building, Milwaukee, have been established for the executive offices. The Universal Power Shovel Co. will continue to be represented in Detroit, Mich., with a branch office located at 462 Book Building.



Universal Power Shovel Co.'s New Factory at Milwaukee, Wis.

General Electric Pays Supplementary Bonus

The General Electric Company on Aug. 6 paid $1,825,832 in supplementary compensation to its factory and office employees who have been in the service of the company for five years or longer. This is the largest bonus ever paid by the company and represents five per cent of the earnings of employes for the six months ending June 30. Approximately one third of the total, or $584,342, was paid to employees at the Schenectady works.

During the past five and one-half years the company has paid a total of $15,757,722 in supplementary compensation to its employees under this bonus plan.

Announcement

The board of directors of International Combustion Tar & Chemical Corporation announces the election of George E. Learned as chairman of the board, succeeding F. J. Lewis; Dr. Walter Runge as president, succeeding W. H. Lewis; and Grant Thorn as vice-president in charge of sales.

It is stated that the resignations of Messrs. F. J. and W. H. Lewis were due to pressure of other business activities. Mr. J. F. Lewis will continue to serve as director of the International Combustion Engineering Corporation, of which the Tar and Chemical company is a subsidiary, and Mr. W. H. Lewis will be associated with it in an advisory capacity.

H. C. Collins to Represent Link-Belt in West

The crane and shovel division of Link-Belt Company, Chicago, announces the appointment of Mr. Harry C. Collins as its official representative in southern California, with offices in Los Angeles.

He will handle the Link-Belt line of shovels, cranes and draglines, devoting his entire time to but two lines—the other one being Plymouth locomotives, made by the Fate-Root-Heath Co., Plymouth, O.

H. C. Collins

For the past several years Mr. Collins has been president of the Collins-Kay Machinery Company, a position that he resigned from July 1 so that he might serve Link-Belt and Plymouth exclusively.

Mr. Collins is reported to be well and favorably known throughout southern California, this being the district he has served for the past 25 years, for seven years of which he was connected with Allis-Chalmers in the capacity of sales engineer.

During the remaining 18 years he has been in business in Los Angeles as a manufacturers' agent, handling general engineering work and heavy construction equipment for dams; municipalities; counties; sand, gravel and rock plants, and for contractors.

The Galion Iron Works & Manufacturing Company, Galion, O., announces the election of Mr. John L. Connors to the board of directors. Mr. Connors has also been made assistant general manager of this company.

R. W. Proctor Joins Cleveland Office of Van Dorn Co.

An announcement of interest to jobbers in the shop equipment field is to the effect that Mr. R. W. Procter, known to his friends as "Doc," has left the Black and Decker organization to become general sales manager of the Van Dorn Electric Tool Company. Mr. Procter has moved to Cleveland, where he will devote all his time and energy to promoting sales of the Van Dorn products.

The joy with which Mr. Procter is being greeted in his new undertaking is expressed by Mr. F. H. Zulauf, vice-president of the Van Dorn Electric Tool Company, in the following words:

"I believe that practically all of our jobbers who know him will agree that no man in our industry ever lost more hair in his sincere desire to help jobber distribution than R. W. 'Doc' Procter of the Black & Decker Manufacturing Company. If there is a manufacturer's man more loyal to the jobbers' cause, or one who has done more to help promote jobber distribution in the shop equipment field, I don't happen to know him. It is unnecessary for me to dwell on the qualifications of Mr. Procter as a merchandiser and sales executive, as his ability in this direction is well known and respected throughout the jobbing fraternity."

Westinghouse Acquires Newark Site for Service Shop

The Westinghouse Electric and Manufacturing Company recently purchased in Newark, N. J., a 22-acre site for a new warehouse and service station. It is planned that this new shop will serve the entire northern New Jersey industrial area.

Located at Haynes Ave. and State Highway, in the Port Newark Development, the site is conveniently located. The city of Newark contemplates building a belt line, connecting all of the railroad trunk lines, and is engaged in an elaborate program of highway improvements and grade crossing removal for this district.

General Electric Announces Change in Employees Insurance Plan

The General Electric Company has announced a revision in their group insurance plan so that premiums paid by new employees will be in accordance with their age, rather than an average rate common to all. President Gerard Swope also announced a modification of the plans for free insurance and additional pensions, also equalizing benefits according to age.

Heretofore, under the free insurance plan, the company furnished the same benefits to all employees, regardless of age. Under the revision the amount of free insurance given the company to new employees will vary according to the age of the person at the time he enters the service.

It is stated that the General Electric Company has more than 80,000 employees at the present time, and has in force a group life insurance policy amounting to more than $160,000,000. There are now approximately 1,000 former employees receiving pensions of disability relief and the pension trust has been built up to almost $9,000,000.

R. B. Marshall Joins Chain Belt Co.

Robert B. Marshall, well known conveyor sales engineer, has joined the Chain Belt Company's Conveyor Division with headquarters at the company's New York City office at 50 Church St. Mr. Marshall has spent the past 21 years in the conveyor business. In addition to the complete line of Rex Conveyors, he will handle the belt conveyors, glass batch handling equipment and silo storage system manufactured by the Stearns Conveyor Company of Cleveland a division of the Chain Belt Co. W. H. Quinn is the New York district manager for the company.

General Electric Exhibit at Aeronautical Exposition

The General Electric Company, according to announcement, a varied and interesting exhibit at the National Air Races and Aeronautical Exposition held in Cleveland Aug. 24 to Sept. 2.

Included in the exhibit were airport beacon lights, floodlights, magneto compass, magnetic compass and airplane engine supercharger.

Representatives of the G. E. Company include H. C. Ritchie, A. H. French and R. Stearns.

Wagner Electric Corporation of St. Louis announces that their Mr. Ralph R. Rugheimer is now a member of the Atlanta branch sales office. Mr. Rugheimer has spent quite a few years in the early days of his training on construction and central station work, and was five and one-half years with the Westinghouse company. He is a native of South Carolina, and a graduate of Newberry College in Electrical Engineering of that state.

Wagner Electric Corporation of St. Louis announces the transfer of F. C. Hosimer from the home office to the Chicago branch. Mr. Hosimer entered the employ of the Wagner Company while a student engineer at Purdue University and has been employed as sales correspondent.

Graver Corporation has appointed Mr. William E. Dunbar as Southeastern sales engineer. Mr. Dunbar will be located at Florida Theatre Building, Jacksonville, Fla. His territory will include the states of Florida, Georgia and Alabama. Mr. Dunbar is no stranger to his territory nor the equipment he is selling, as he has been engaged in the water softening and filtering business in this territory for many years.

Sales Force Representatives, Manitowoc Engineering Works. Upper Row—J. A. Forsythe and J. A. Egan. Middle Row—C. H. Moore, C. C. Miller, R. A. Chadwick, E. B. Nickles and M. G. Hennessey. Lower Row—T. O. Putt, J. E. Thiell, J. W. Frain, F. C. King and J. J. Reilly

Water Works and Sewerage

Vol. LXXVI OCTOBER, 1929 No. 10

Left—Intake Shaft and Forebay at Edisto River. Right—Intake Shaft and Forebay, Looking Upstream

The New Water Supply of Charleston, S. C.

Edisto-Ashley River Tunnel Driven 4½ Miles Through Marl

By J. E. GIBSON

Manager and Engineer, Water Department, Charleston, S. C.

As a result of the unprecedented droughts occurring in the southeastern states during the fall of 1926, the Commissioners of Public Works of the city of Charleston, S. C., operating the water department, authorized the department to make a study of the water supply resources of Charleston with the idea of developing an additional supply. These studies were carried out during the summer of 1927, and resulted in the department recommending the Edisto River at Givhans Ferry as the supply.

Goose Creek, the present supply source, has a drainage area of 42½ square miles. Lying immediately to the west of this drainage area is the Ashley River, having a drainage area of 245 square miles, upon which, at Bacon's bridge, there have been built a dam and an auxiliary pumping station. The Edisto River lies to the west of the Ashley River and has a drainage area at Givhans Ferry of 2,476 square miles, with the divide between the Ashley and the Edisto within ¼ mile of the Edisto River.

River Water Diverted Through Tunnel.—On account of the nature of the drainage area above Bacon's bridge—low, swampy, heavily timbered area, with marl formation lying within two to three feet of the surface—the flow of the Ashley River at Bacon's bridge reaches as low a quantity as 50,000 gallons per day, whereas the Edisto River to the west of the Ashley has an average flow in excess of 300 m.g.d. with a minimum flow probably never less than 150 m.g.d. It was proposed, therefore, to divert sufficient waters of the Edisto River into the Ashley River to produce at all times an adequate supply of water for the pumping station located at Bacon's bridge on the Ashley River. This pumping station delivers the water under a 26-ft. static head into the drainage area of Goose Creek, whence the water flows by gravity to the Goose Creek pumping station and filter plant for ultimate use. A series of levels run between the Edisto River and Goose Creek developed the fact that the fall between the normal elevation of the water in the Edisto River at Givhans Ferry and a small tributary of the Ashley River that could be reached within 4½ miles of Givhans, was 13 ft.; that is to say, the elevation of the Ashley River at the nearest point was 14 ft. and the Edisto River had a normal stage of water of 27 ft. The divide between the Edisto and the Ashley River is a high table-land with an average elevation of 60 ft. for from 1½ to 2 miles. Therefore, to divert the waters from the Edisto to the Ashley, it was necessary either to tunnel this distance or to put in a pumping station and pump the water through pipes across the table-land. The latter consideration proving prohibitory as to cost for the quantity of water required, it was determined to tunnel. This constitutes the unusual feature of the job—a 4½-mile tunnel in the low, flat coastal plain of South Carolina. The tunnel is really not a tunnel in the sense that we ordinarily think of a tunnel, but is rather a conduit as it is well below the hydraulic grade line between the two sources and acts as an inverted syphon.

Tunnel Driven in Marl.—The beds of both the Ashley and the Edisto rivers are eroded down to the marl; in fact, the east bank of the Edisto is a sheer bluff of about 30 ft. of marl formation. This marl is a semi-limestone formation that can be readily cut by sharp tools such as mattocks or picks. It is homogeneous in nature and shows very little erosion by the current. It was this condition that led Mr. McDowell, assistant manager and engineer, and the writer to decide on tunneling, as all our in-

vestigations developed the fact that the marl would withstand erosion even where the velocities were very high. Test borings were made every half-mile along the line of the projected tunnel and the elevation of the marl determined, and with this information available it was an easy job to locate the tunnel at the proper elevation to maintain a satisfactory covering of marl at all points.

Pumping Scheme.—The design contemplates ultimately carrying the tunnel to the Goose Creek pumping station, a total distance of 22½ miles. The work undertaken, however, embraced only the tunnel from the Edisto River to the tributary of the Ashley River, a distance of 4½ miles, passing under the divide between the two rivers and thence continuing with 1½ miles of open canal. The canal is really an improvement in alignment of the small tributary into which the outlet shaft of the tunnel is discharged. Water will flow from the Edisto River through the tunnel for a distance of 4½ miles, thence through improved canal to the Ashley River proper and thence down the channel of the Ashley River 8 miles to the Bacon's bridge pumping station. Here it will be pumped by Diesel-engine-driven centrifugal pumps through a 24-inch pipe line to the Goose Creek drainage basin. The present capacity is 5 m.g.d. with provision made for increasing to 10 m.g.d. when required. When this latter figure is reached, it is hoped that funds will be available to continue the tunnel work the remaining 18 miles to the Goose Creek pumping station. The ultimate capacity of the tunnel when completed to Goose Creek will be 25 m.g.d. and the fall in the tunnel from the inlet to the outlet at Goose Creek will be 18 ft. The tunnel section is horseshoe shaped, the upper half being a circle of 3½-ft. radius and the lower quarters and bottom being segments of 7-ft. radius struck from the ends of the horizontal diameter and the top of the upper circle.

Cost to Date.—Plans were completed, and bids were opened on December 5, 1927. The contract was awarded to the MacDougald Construction Co., of Atlanta, Ga., on January 6, 1928. Charles C. Case was representative owner in charge and Barry Tufts was general superintendent. The total cost of the work, exclusive of the open canal, which has not as yet been completed on account of the continued wet weather and the resulting inaccessibility, was $383,575.26, made up as follows:

Engineering, preliminary surveys, inspection during construction and overhead	$ 23,432.58
Legal expense, land and rights-of-way	10,203.12
Contract, MacDougald Construction Co.	349,939.56
Total	$383,575.26

Composition of Marl.—There were no particularly difficult engineering feats required in the construction of the tunnel. The underlying geologic formation of the coastal plain from Georgetown at the mouth of the Santee River to as far south as Savannah is marl, which occurs in the Cretaceous, Eocene, Oligocene, Miocene, Pliocene, and Pleistocene periods. The elevation of the marl formation on the Cooper River and Goose Creek is about —3, mean sea level, with a gentle rising slope toward the west until it reaches the Edisto River, where it outcrops in a sheer bluff on the east bank of the Edisto River 15 or 20 ft. above mean water level, or elevation 42 ft. above mean sea level. The marl through which the tunnel is constructed probably belongs to the Miocene period.

The analysis of the marl runs about as follows:

Sulphur trioxide	Trace
Silicon dioxide	13.04%
Iron and aluminum oxide	1.78%
Magnesium oxide	Trace
Calcium oxide	*46.16%

*Equivalent to calcium carbonate 81.76%.

Shafts and Headworks.—The contract as awarded consisted of the inlet portal shaft, the exit shaft, three intermediate shafts located about one mile apart and 4½ miles of tunnel, from a 40-ft. minimum to a 65-ft. maximum depth below the surface of the ground. The order of construction was to sink all shafts to the desired grade and then drive headings in both directions from the intermediate shafts and in one direction from the inlet and outlet shafts. The tunnel was given a slight ascending grade from each shaft heading so that any water that might be encountered during construction would drain to the shafts. Very little water was encountered. All shafts are concrete lined from bottom to surface and provided to receive stop logs so that any section of the tunnel can be isolated and unwatered if required.

The headworks consist of a concrete entrance having an opening into the river 20 ft. wide, with a minimum depth of 3 ft. at low-water stage of the river. The water will flow into this inlet, thence through racks and screens controlled by two 48-in. square sluice gates, down the inlet shaft and into the tunnel. The minimum elevation of the water in the Edisto River is taken as 23 ft.; normal, 27 ft.

Methods of Construction.—The contractor erected at each shaft a stiff-leg derrick with gasoline or air-driven hoists for lifting the muck from the shaft and tunnel, and at inlet shafts No. 1 and No. 3 erected a 1,050-ft. Diesel-engine-driven Sullivan compound compressor. These units were connected on the surface with 3½-in. wrought-iron pipe, and at each end extended to include the inlet and outlet shafts. At all shafts necessary air valves and take-off lines were connected to this air line. A small gasoline-driven electric light plant was installed for furnishing light in the tunnel and shafts. Under ground, the air lines were 2½ and 3 in. in diameter.

At first it was thought unsafe to do any blasting in the tunnel but careful experimentation after the work started disclosed that a moderate amount of

Left—Intermediate Shaft No. 3 and Spoil Bank. Right—Outlet Shaft and Spillway Just Before Completion

powder or gelatin could be used to advantage. Light charges of ½ lb. of 40 per cent gelatin in each of five holes at a depth of from 4½ to 5 ft., spaced about 2 ft. from the circumference of the tunnel, were found to remove a satisfactory amount of material without injury. After this material was removed, the tunnel section was finished to size with pneumatic spades and hand adzes. Alignment was maintained as in other tunnel construction. The muck was removed in small removable body cars over a light-rail 20-in.-gauge track to the shafts, where the body of the car was raised to the surface. Here the muck was dumped into a larger car and carried to spoil banks. Man power was used for muck cars.

Progress of Work.—Progress in driving the tunnel was made as follows:

The heading between the inlet shaft and the west heading of No. 1 shaft was holed through September 15, 1928.

The east heading from No. 1 shaft to the west heading of No. 2 shaft was holed through October 2, 1928.

The east heading between No. 2 shaft and the west heading of No. 3 shaft was holed through on the afternoon of November 1, 1928.

The east heading from shaft No. 3 to the west heading of the outlet shaft was holed through November 9, 1928.

The maximum error in alignment at meeting points was 17 in. and the minimum ½ in. We consider this exceptionally good engineering work, for the longest base line available at the commencement of the work was the diameter of the shafts, a maximum length of 11 ft., and a minimum length of 8 ft. The lapse of time between the holing through of the last shaft and the final completion of the work was taken up in the final finishing of the surface of the tunnel, completion of the concrete shafts, capping, removal of plant equipment, etc.

The marl throughout the 4½ miles of tunnel was quite uniform in character, showing no tendency to squeeze or fall. The tunnel is unlined throughout its length and has been filled with water since April 1, 1929, but has not been put into service as the rainfall has been more than sufficient to maintain the Goose Creek impounding reservoir full to overflowing.

Engineering Personnel.—All engineering work was carried out by the department, with F. B. McDowell, Jr., as engineer in immediate charge and Gabriel Cannon as resident engineer.

North Carolina Water Works Men Meet in November.—The 9th annual convention of the North Carolina Section, American Water Works Association, and 6th annual meeting of the North Carolina Sewage Works Association will be held jointly at the Sheraton Hotel, High Point, N. C., on Nov. 4, 5, and 6, 1929.

Artesian Water Supply of Memphis, Tenn.

The Geological Survey, United States Department of the Interior, has undertaken an investigation of the ground-water conditions in Tennessee in cooperation with the State Geological Survey. As a part of this larger program, about two months was spent in Memphis and vicinity during the summer of 1928 by F. G. Wells, of the United States Geological Survey. Automatic water-stage recorders were placed over representative wells and obtained continuous records of the depth to the water level in these wells. These records show with much precision the relation between the withdrawal of artesian water and the underground inflow of water to recharge the artesian reservoir. The longer the period covered by such records the more accurate are the conclusions that may be drawn. For this reason it is planned to continue observations at Memphis for several years.

Manuscript copies of a preliminary report giving the data that have thus far been obtained and such generalizations as can safely be made at this stage of the investigation, together with a map of Memphis showing the location of wells, tables of well data and chemical analyses, and illustrations, are now open for public inspection at the office of the Tennessee Geological Survey at Nashville, and at the Memphis Chamber of Commerce. This report gives a brief history of the artesian-water development of the area from 1867 up to the present time. The geology of the region is described, with particular reference to those formations that are important as producers of water. The Holly Springs and Grenada formations are the two most productive water-bearing formations in the area. The Holly Springs formation is encountered at about 450 ft. below the surface and continues to a depth of about 1,000 ft. The Grenada formation has a maximum thickness of 400 ft. and lies about 75 ft. below the surface. The Ripley formation, which also yields considerable water, is encountered at a depth of about 1,300 ft.

The total average daily pumpage from both public and private wells was 37,385,000 gal. in 1920 and remained below this figure until 1928, when it amounted to 38,600,000 gal. It is estimated that in 1928 about 2,000,000 gal. of water a day was pumped from the Ripley formation, the remainder coming from the group that includes the Grenada and Holly Springs formations.

The development of water supplies in Memphis during the last 10 years has caused an increase of over 1,000,000 gal. in daily pumpage, but as there has been a large increase in the area drawn upon by wells, the lowering of the water level has been less than if the wells had been concentrated in a smaller area. In view of the large quantity of water pumped, the loss in head is not great, and it is believed that additional supplies can be obtained, but future developments should be distributed as widely as possible. If more water is pumped the head will doubtless decline further, but for any increase that is expected in the immediate future the decline would hardly be great enough to be serious.

Analyses of water from wells in the Grenada formation show that in general it is fairly soft and has a moderately low content of dissolved mineral matter. Except for the slight trouble and expense involved in the removal of iron, water from the Grenada and Ripley formations is likely to be thoroughly satisfactory for all ordinary purposes.

New 750,000,000 Gal. Water Supply for Ford Plant

Work has been started on a 2¼ mile water tunnel from the Detroit River to the Ford Motor Co. plant at Rouge, Dearborn, Mich., to supply the expanding needs of the plant with 500,000 gal. of water a minute. This volume is 100,000 gal. a minute more than present supply which is now withdrawn from the Rouge River through the slip, the docking place for Ford ships. Ninety per cent of all the water is used for cooling purposes. This is heated up and returned to the lower Rouge River below the plant through a discharge tunnel.

The increased demand for water for manufacturing purposes followed adoption of plans for doubling the capacity of the power plant, with provisions for further anticipated expansion. Several power plant units are now being replaced by two 110,000 kw. turbine-generators, each of which alone requires 150,000 gal. of water a minute for condenser cooling.

The new tunnel, to be completed in a year, is of the gravity type and is being laid 40 ft. underground. Its inside diameter is 15 ft., and it is to have a concrete lining 25½ in. thick.

Present requirements are approximately four to six times greater than supplied by the upper Rouge River. Therefore, the balance must be drawn from the lower Rouge River which reverses the current from the discharge tunnel to the slip. This returns the warm discharge water to the slip and the constant recirculation raises the temperature 18 or 20 degrees above the average river temperature.

To overcome that objection and also to provide for adequate quantities for further expansion the company was faced with the necessity either of tapping the Rouge farther upstream and installing a cooling spray or to tap other sources. By tapping the Detroit River, more than two miles away, the company is assured of unlimited supply and will be able to use its present River Rouge system for disposal of water after having passed through the plant.

New Methods and Equipment in Filtration Plant Operation

Problems Discusssed at the Ohio Conference on Water Purification

SEVERAL new methods or new equipment were described at the 8th annual Ohio Conference on Water Purification. The discussion of one of these "The Use of Carbon Dioxide Scrubber Water for Removing Sand Incrustation," brought out some entirely new ideas on recarbonation. The notes following are taken from the recently issued report of the conference.

Use of Pulverized Quick Lime at Portsmouth

By F. E. SHEEHAN
Superintendent of Filtration, Portsmouth, O.

Lime is used at Portsmouth ordinarily to keep the carbon dioxide content down to a minimum. However, during the last few years, the phenol taste trouble has compelled us to abandon chlorine treatment for days and weeks at a time and during these periods, it has been necessary to resort to excess lime treatment to maintain a factor of safety. To obtain a causticity of about 5 p. p. m., from 2.3 to 2.5 g. p. g. CaO must be used, and with a pumpage of 7,000,000 gal. per day, this amounts to about 2500 lb. of burnt lime or 3500 lb. of hydrated lime.

Lime was first used in the hydrated form in solution feed, but the annoyance of mixing so often and the resultant dust that covered the plant caused us to resort to dryfeed machines, exclusively. In connection with these machines, large hoppers were built, from which the lime was fed to the machines. The use of hydrated lime in these hoppers was not a success as the lime occasionally arched in the hopper and did not feed at all or at other times it fed too rapidly and overflowed the machines. Accordingly we changed to the use of pebble lime which had just come upon the market. In doing so, we added a mechanical slaker. The lime dryfeeds were placed over cylindrical cast iron chambers in the centre of which were set vertical paddles. By means of bevel gears, these paddles were operated from the countershaft which ran the dryfeed machines. The pebble lime worked excellently in the hoppers and slaked quickly, but great difficulty was encountered from the insoluble cores. When large amounts of lime were fed, these cores would collect in the bottom of the slaker and stop the agitator. Accordingly we tried a car of ground burnt lime and the latter, at any rate for small plants, appears to satisfy any demand placed upon it. Shipped in either 180 lb. steel containers or 90 lb. paper-lined burlap sacks, it retains its CaO content indefinitely. Shipped in this manner, it is much easier to unload than hydrated lime which comes in 50 lb. paper sacks, the latter being easily torn and a constant source of lime dust. The ground lime is fed by the dryfeed machines as perfectly as alum, showing no tendency to arch in the hoppers or to overflow. There is apparently no need of assisting the slaking action as the lime almost immediately forms a milk of lime solution in the mixer, comparable to the action of hydrated lime used under similar circumstances. There is no heat developed when small amounts are used, but chemical tests show that no part of the lime is lost through incomplete reaction. I believe it may be used in place of hydrated lime without using elaborate equipment for slaking purposes. The cost of ground quicklime on a unit basis is somewhat less than hydrated lime. All things considered, I believe it to be the most satisfactory manner in which lime may be employed.

Discussion.—The idea that quicklime could be hydrated or put into solution quickly without evolving considerable heat was new to most of the conference members. No appreciable amount of heat is developed in the slaking process at Portsmouth where the lime is discharged into a small solution tank and from which it flows almost immediately to the mixing chambers through approximately 100 ft. of pipe. Mr. Hoover stated that the pulverized quicklime was not the only kind of lime which would slake in this way. He mentioned a kind of crushed quicklime which, after 30 minutes stirring in cold water, goes to pieces with no heat evolved.

A Small Sand Washer and Gravel Grader

By F. E. SHEEHAN
Superintendent of Filtration, Portsmouth, O.

During the last few years, all of the filter units at Portsmouth have been completely overhauled. This has been in connection with the removal of air pipes from the filters and the making of slight changes in the underdrain system to enable us to obtain a higher rate of wash. The overhauling presented no serious problem with the exception of the grading of the gravel before replacing in the filter. The sand was merely ejected to a platform and injected back into the filter. The screening and grading of the gravel by hand, however, was a slow and tedious job, and we looked about for some means of mechanical screening. After experimenting, we finally put together a shaker screen that has successfully handled the gravel from the filters. It consists of a series of screens—2 ft. by 3 ft.—mounted one above the other with the coarse screen at the top and the set of screens as a unit, suspended to swing sideways in a wooden frame. By means of an eccentric arm working from a countershaft, operated by a 3 h. p. motor, the screen was shaken about 250 times per minute and the different sizes of gravel led to separate piles by means of chutes. This shaker has done the work well, but to obtain a successful separation, the gravel had to be perfectly dry. About one-half the gravel can be ejected upon the platform. The remainder has to be shoveled out of the filter, wheeled to the platform, washed, and allowed to dry.

The idea occurred to the engineer of a concern which manufactured sand-screening machinery, who happened to watch our makeshift shaker in operation that use could be found for a self-contained unit for washing and screening filter gravel and, accordingly, he drew up a design for such a unit.

The outfit consists of a revolving screen with central shaft, operated at a speed of about 15 r. p. m., a 2 h. p. motor furnishing the power and a planetary speed reducer producing the low speed, all mounted on a structural steel frame. The gravel may either be injected or shoveled into a scrubbing chamber which is perforated to allow the sand, which is always present in small amounts, to be removed from the gravel. The sand and possibly some of the smaller sizes of gravel pass from the scrubbing chamber to the sand jacket which contains small perforations to allow the sand to pass to the collecting chamber beneath the screen. This tank also catches the dirty wash-water which may be led to the sewer from the tank by means of an overflow nozzle at top of tank. The sand is continually removed from the tank by means of a drag-line, with chain and sprocket drive operated also by the driving motor. The gravel passes from the scrubbing chamber and the sand jacket to the screen proper, which may contain three or four sections or as many as desired, depending upon the gravel to be screened and the number of sizes required. The different sizes may be led from the screen into separate piles by means of chutes.

The entire outfit, mounted on trucks, may be moved easily, in fact it could

be set up near a filter, and the entire gravel content could be removed, washed, graded and returned to the filter in a day's time. The machine, as described, will handle about 100 yds. of gravel in a day. It appears that, since periodic overhauling of filters is absolutely necessary, such a unit as the one described could well be an integral part of the modern water purification plant.

Experiment on Using Broken Stone Instead of Gravel in Filter Bottoms

By O. F. SCHOEPPLE
Chemist-in-Charge, Sandusky, O.

One of the filters at the Sandusky plant gave some little trouble with a very uneven distribution of wash water, the development of hard spots and inversion of sand and gravel. In checking over the filter material in this unit it was found that there was but 9 in. of gravel of which only 2 in. was of a size greater than ½ in. Some little difficulty was experienced in finding nearby satisfactory gravel in the larger sizes. This suggested the use of limestone.

Before it was decided to increase the gravel depth by the use of limestone in the filter bottom an inspection of the crushed limestone in the bottoms of the sewage filters at the Ohio Soldiers and Sailors Home at Sandusky was made. This stone has been in place for something like 30 years and inspection of it indicated that it was in practically the same condition as when placed.

In the large limestone quarries just south of Sandusky are found several grades of limestone all of dolomitic character but differing considerably in hardness. The type selected for this experiment was the same grade that was used on the Akron sewage plant work. The size used was 2½ in.

One filter was reconstructed for experimental work and 4 in. of 2½ in. hard dolomitic limestone was used on the New York Continental Jewel filter bottom. On this stone was placed the original gravel and then the filter sand.

This reconstructed filter was placed in service on June 12, 1928, and to date has given no trouble with gravel inversion. It has developed no hard spots and shows a very even distribution of wash water. No examination of the stone in the filter bottom has been made to date. It is expected to take samples of the stone every year for comparison with the condition of the original stone when added.

Discussion.—The specification calling for round gravel in preference to irregular shaped crushed rock in filter bottoms are wrong in his opinion Mr. Burgess stated. The irregular particles become bedded, and upon examination you can find that in many cases they have not moved after a filter is washed. He cited the case at Wilmington, Dela., where irregular shaped rock was used in the filter bottoms because they would stay in place better than the round gravel.

Smith reported that crushed stone had been in place in the filters at the Lima State Hospital filter plant for two or three years. The rock was put in when, in overhauling the filters, it was decided to increase the depth of the gravel. As no gravel was immediately available some crushed stone was used. Very good distribution of wash water has been obtained since.

If the use of crushed limestone proves to be satisfactory for replacing the larger sizes of gravel in filters it will go a long way toward solving the problem of obtaining satisfactory supporting material for the sand at many places in Ohio.

Use of Carbon Dioxide Scrubber Water for Removing Sand Incrustation

By J. M. MONTGOMERY
Superintendent of Waterworks, Piqua, O.

THE method of treatment of the water supply at Piqua was described in full at the Seventh Annual Conference. It will be remembered that following the heavy lime treatment, the water is treated with carbon dioxide so as to reduce all the hydrate and part of the carbonate alkalinity to bicarbonates. That is, a considerable amount of carbonate alkalinity is left in the water influent to the filters. This, of course, has resulted in some incrustation of the sand.

The carbon dioxide plant consists of a coke burning furnace, a scrubber and drier and a compressor to force the gas through a grid system in the carbonation chamber. Water used in scrubbing the gas has been run to waste until recently when the idea was conceived of passing this scrubber water through one of the idle filters, for the purpose of removing the incrustation from the sand. The scrubber water is highly charged with carbon dioxide and it contains some sulphuric acid which also aids in removing the incrustation. It is introduced into the underdrains of the filter and allowed to pass up through the sand and into the wash water troughs and to waste. The alkalinity of some samples of this scrubber water after it passed through the filter has been as high as 1000 p. p. m. This shows that it is removing the incrustation. Unfortunately insufficient analytical data are available to tell just what can be accomplished, and for this reason it is not known whether it is more economical to treat the sand in this manner or to allow the incrustation to accumulate for several years and to then replace the sand. That problem will be worked out.

Discussion.—Considerable interest was manifest in Mr. Montgomery's description of his method of removing incrustation from sand. Mr. Woodward of the Carnegie Steel Co., raised the question as to whether this method of treatment would remove magnesium carbonate incrustation as readily as it would calcium carbonate. Mr. Montgomery replied that the heavy lime treatment employing 40 p. p. m. causticity precipitated practically all the magnesium in the form of magnesium oxide, which is very flocculent, and in character very similar to alum floc. There is very little magnesium left in the water which can incrust the sand. Mr. Cameron inquired as to the corrosive action of the scrubber water on the piping in the underdrain system of the filter. It seemed to be the opinion of many present that undoubtedly some trouble might result from this practice of introducing scrubber water into the underdrain system of a filter, especially if the scrubber water contained much sulphur. Sulphur can be very largely removed from the scrubber water by replacing the coke in the scrubber with limestone. It is planned, Mr. Montgomery said, to put limestone in the scrubber to remove the sulphur gases. Mr. Hoover, in summing up the points brought out by the paper, and in the discussion, said that he feared that we were getting away from the original purpose of recarbonation. The original purpose was to prevent incrustation. The next development was to over-treat the water with lime, and then apply only enough carbon dioxide to reduce hydrate alkalinity, but leaving normal carbonates in the water. This method of treatment still leaves the water in an unstable condition, and causes incrustation of the filter sand. If it is desired to obtain low alkalinities in the recarbonated water, he said, carbon dioxide treatment should be carried out in two stages; the first application should be at a point near the outlet of the mixing chamber. The quantity should be just sufficient to precipitate magnesium which is flocculent and will carry down the finely precipitated calcium carbonate. The second point of application should be at the end of the settling basins just before filtration. A water treated in this way will have a low alkalinity and will not incrust the filter sand.

Mr. Clark commented on the idea of double recarbonation by saying that in the design of the new water purification and softening plant at Fremont, provision had been made for three points of application for carbon dioxide. The first point is between the clarifier and the sedimentation basin, hoping by application of carbon dioxide there to obtain better deposition of the precipitate formed. The second point is in the regular recarbonation chamber between the sedimentation basins and the filters. A third point of application has been provided in the clear well. However, Mr. Clark stated that he questioned how

far treatment at this point was desirable or necessary.

Regarding the concentration of carbon dioxide in the gas used in various recarbonation plants, the question was asked as to what was the thought underlying the higher concentration of carbon dioxide. It was answered by Mr. Hoover as follows: "We have at Columbus an air compressor which pumps 800 cu. ft. of gas per minute. If this gas contained only 5 per cent carbon dioxide instead of 20 per cent, it would be necessary that we have a compressor of four times the capacity. In other words one which consumes four times as much power."

Liability for Water Borne Diseases

Courts have held on numerous occasions that the owner of a water supply, whether a municipal or private concern, was liable for damages caused by sickness resulting from the use of a polluted water furnished by him. The following synopsis of such decisions was given in an appendix to the final report of the committee on Cross-Connections of the New England Water Works Association:

Green v. Ashland Water Co. (1898) 101 Wis. 258: "If defendant knew, or from the situation ought to have known, the water it is distributing was dangerous for domestic use, from some cause not discoverable ordinarily by the exercise of reasonable care, it owed the duty to its customers of disclosing that danger, and a failure so to do, knowing that such customers were liable to use the water through ignorance of its character, was a fraud in law, rendering the defendant liable to legal damages to any person injured by such fraud without fault on his part, and it was also a failure of duty amounting to actionable negligence as well, to which the same liability is incident." Five thousand dollars verdict involved.

Lockwood v. Dover (1905) 73 N. H. 209: Negligence was alleged in that defendant municipal corporation failed to clean out its water pipes or to provide means whereby they could be cleaned out, and that in consequence thereof foreign and decayed matter became lodged in the city's pipes, entered the pipes leading to the plaintiff's dwelling and was there drunk by the plaintiff's intestate, causing him to sicken and die. It was held that the defendant was liable.

East Grand Forks v. Luck (1906) 97 Minn. 373: Based upon a study of the following cases: Reed v. City of Anoka, 85 Minn. 294, 88 N. W. 981; Walla Walla City v. Walla Walla Water Co., 172 U. S. 1, 19 Sup. Ct. 77, 43 L. Ed. 341; Illinois Trust & Savings Bank Co. v. Arkansas, 76 Fed. 271, 22 C. C. A. 171, 34 L. R. A. 518, Judge Elliot said: "When the municipality enters the field of ordinary private business, it does not exercise governmental powers. Its purpose is not to govern the innabitants, but to make for them and itself private benefit. As far as the nature of the powers exercised is concerned, it is immaterial whether the city owns the plant and sells the water, or contracts with a private corporation to supply the water. It is not in either case, exercising a municipal function. . . . When a municipality engages in a private enterprise for profit, it should have the same rights and be subject to the same liabilities as private corporations or individuals.

Keever v. Mankato (1910) 113 Minn. 55: "When a municipality voluntarily engages in selling and distributing water to customers for its local advantage or profit, it enters the field of ordinary private business, and has the same rights and is subject to the same liabilities as private corporations or individuals with respect to damages from impurity of the water. . . . It is obvious that a sound public policy holds a city to a high degree of faithfulness in providing an adequate supply of pure water. Nor does it appear why the citizens should be deprived of the stimulating effects of the fear of liability on the energy and care of its officials; nor why a city should be exempt from liability while a private corporation under the same circumstances should be held responsible for its conduct and made to contribute to the innocent persons it may have damaged. Five thousand dollars awarded.

Jones v. Mount Holly Water Co. (1915) 87 N. J. L. 106: "Water is a necessity of life, and one who undertakes to trade in it and supply customers . . . is bound to use reasonable care to see that whatever is supplied for drink . . . shall be reasonably pure and wholesome, and that negligently furnishing water which is deleterious to that human body or health will furnish a valid cause of action to a customer injured by the use of the water." "Actual notice or knowledge of the unwholesomeness of the water of the defendant company was not an essential element to be proven in order to establish the defendant's liability; it was sufficient if there was testimony tending to show that the defendant, in the exercise of reasonable care, might have discovered the unwholesomeness and dangerous condition of the water." Seven hundred fifty dollars awarded.

Vennen v. New Dells Lumber Co. 154 N. W. 640: The facts in the case were briefly these; The employing company had a dual water supply in its factory; one source obtained from the city mains, the other from a nearby stream which was badly polluted. The two water distribution systems were connected by a pipe in the boiler room protected by a Globe valve reinforced by a check valve set against the polluted supply. A number of employees were in the habit of obtaining drinking water from a faucet in the boiler room which was located so that the polluted river water could reach it. Subsequent to the epidemic of 13 cases of typhoid fever and two deaths, the valves were examined and found leaky. The court held on the demurrer of the defendant that typhoid fever was a compensable accidental injury. Sued for $20,000.

It is significant that in another case—Alex Vander Leest v. John Hobert Company, Industrial Commission of Wisconsin Workmen's Compensation 10th Annual Report, July 1, 1921 to June 30, 1922, page 59 it was held by the Industrial Commission that compensation was due nineteen employees of the company who had contracted typhoid fever by use of water from a polluted well of the company. This case, however, was not carried into the courts. Compensation awarded $2,233.61, medical aid $1,742.94. Total $3,976.55.

Stubbs v. City of Rochester (1919) 226 N. Y. 516: One seeking to hold a city liable for injury by typhoid fever, alleged to have been contracted from defendant's polluted water system, is not bound to eliminate all other possible causes of the disease to establish defendant's liability. That a city's contaminated water supply was the source of typhoid fever in a citizen may be found from the fact that he drank water near the point of contamination, that some sixty (60) other cases developed in that vicinity, that his habits were such as to tend to exclude another probable source, while his physician testified that such contamination was the source of his illness.

Canavan v. City of Mechanicsville, 128 N. E. 882: A private water company or a municipality is not an insurer, nor liable as a guarantor, of the quality of the water it furnishes to its customers by the customary means of pipes and faucets, and cannot be held liable for injuries caused by impure water furnished by it, unless it knew or ought to have known of the impurity. Its duty is that of exercising reasonable and commensurate care and diligence in providing an adequate supply of wholesome water at all times.

In the case above cited the court decided that the complaint stated a valid cause of action against the defendant city on account of typhoid fever contracted by plaintiff and his children from drinking impure water.

Roscoe v. City of Everett, 239 Pacific 831: In discussing the case the court said: "It is sufficient to say that the evidence discloses that on April 11, 1923, a six-inch main was laid to connect two laterals, and that when the connection was so made it permitted free circulation of water to the city users in the district served, and also better service to the Eclipse Mill Company. At the time this connection was made, there was a by-pass which had existed for a great many years. With the making of the connection there was no longer any need for the by-pass. This by-pass had in it what is known as a gate value A—a valve worked by hand, and which when closed, effectually prevented water from passing through the pipe." . . . "There was evidence that the city never inspected the valve in the by-pass from the date of its installation." . . . "The ease with which the valve could be sealed or by-pass removed and the eminent danger to be apprehended by failure so to do are strong factors in the question of the city's negligence." Award $60,000.

Water Company Gives Prizes to Employees for Suggestions Improving Service

Henry W. Drury is the winner for 1929 of the prize of $200 in gold awarded annually to an employe of the Hackensack Water Co., Weehawken, N. J., for the best suggestions to improve service, it is announced by the president of the company, Nicholas S. Hill, Jr.

Four suggestions made by Mr. Drury, who is the commercial agent of the company, have been adopted by the company's departmental heads as the basis of new and better practice.

One of Mr. Drury's proposals was that plumbers be permitted to set and reset meters on customers' services. This has been approved by the Master Plumbers' Association.

Substitution of a simpler form of office record of the establishment of service than the present customers' application blank was another suggestion, which is now being worked out.

A third suggestion was that a simple system of customers' credit rating be established, and that the system of collection of accounts be rebuilt around this rating to the end that collectors' calls may be eventually eliminated. Rating is now well under way, and the result has been better collections with less calls and improved public relations.

Fourthly, Mr. Drury proposed the simplification of the inspection of new meter installations by meter readers.

These suggestions were among many submitted by other employes to the bureau of new ideas, established by the company about three years ago as a part of a general program of service betterment. Previous suggestions, according to Mr. Hill, have proved of great value to the company and to the public.

"All employes were requested to make suggestions which, in their judgment, would increase efficiency of operation and extend the usefulness of the company," Mr. Hill explained. "The response has been both emphatic and enlightening. This year many of the suggestions were so meritorious that the selection of the best was no easy task.

"The bureau of new ideas is developing as a constructive force in anticipating the water supply needs of Bergen and North Hudson Counties. Its operation means increased vigilance on the part of the entire organization of the Hackensack Water Company in the public interest."

Encouraging Watering of Trees.—In an attempt to encourage residents of Kearney, Neb., to preserve their trees, the city water works cut the excess water rate in half for the month of September.

The New Sewage Disposal Works of Highlands, New Jersey

Design and Construction Features of Plant for Fluctuating Load of 2,500 to 15,000 People

By LESTER H. BURNS

ON the Sandy Hook Bay, just north of the Navesink River, lies a range of hills overlooking the Atlantic Ocean. This range of hills colloquially referred to as the "Highlands," is the highest point on the Atlantic Ocean between Maine and Florida. The entire section, combining its wide, sandy beaches and the exhilarating salt sea air with the restfulness of wooded slopes, has been generously favored by Nature. Small wonder, that each year hundreds of thousands of people are attracted from the congestion of the nearby cities to enjoy the beauty of the "Highlands" and the healthful recreations which they offer.

These great numbers of people coming during the short summer season greatly overtax the facilities of the section for administering to the elementary needs of the normal population. During this annual influx of summer visitors, many problems face the governing bodies of the towns comprising the "Highlands." The most pressing question at present is the proper disposal of waste and the elimination of the pollution suffered by the beaches and surrounding waters. This problem is a result of antiquated sewage systems.

The taxpayers of the "Highlands" towns realize that the evils resulting from water pollution will cause serious economic losses if left unchecked; and they realize that these conditions must be changed. As a result, new sanitary systems are being installed to treat this waste by the most modern and approved methods of sewage disposal.

The Borough of Highlands, N. J., by the installation of a modern, well equipped sewage disposal works, designed by Remington & Vosbury, consulting engineers of Camden, N. J., is the most recent town in the ever-growing chain of communities that have taken steps to eliminate the noxious conditions, the result of the old methods of sewage disposal. The system under construction has been designed to meet not only the requirements of the normal population of 2,500, but also the needs of a transient population, which during the summer season reaches a total approximating 15,000 people.

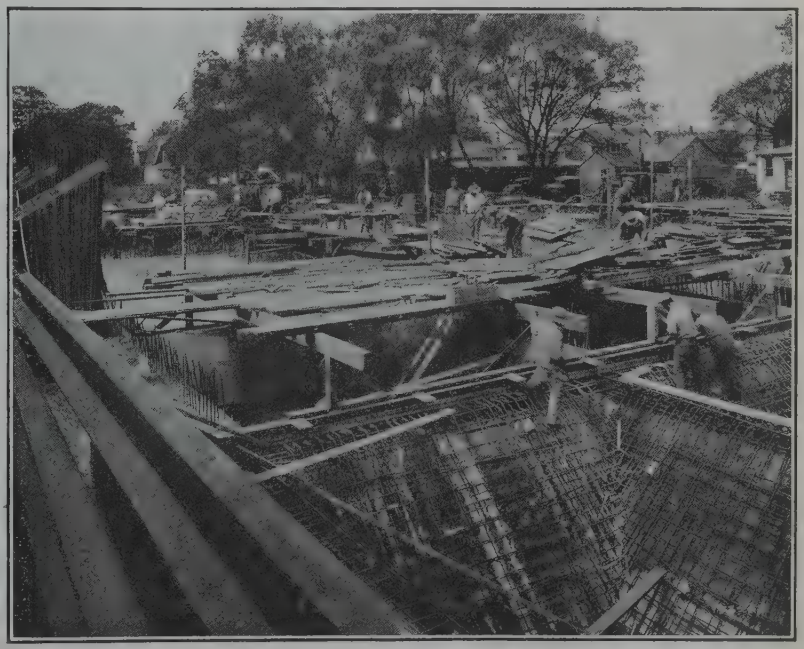
The contract for the construction of the system was awarded to Mahlon Averill, general contractor of Newark, N. J. The construction is under the supervision of B. B. Skinner, and the engineer is Mr. MacDonald of Remington and Vosbury. When completed, the entire disposal plant will embody all the refinements which modern engineering skill has developed. The gravity septic tank principle will be employed to treat the waste.

General Features of Plant.—The system consists of the old network of sewers, which carry the influent to two small pump houses at either end of the town. From these points it is pumped through a 20-in. main leading to the disposal plant, which consists of a large pump house and four septic tanks of four hoppers each, where the waste is treated.

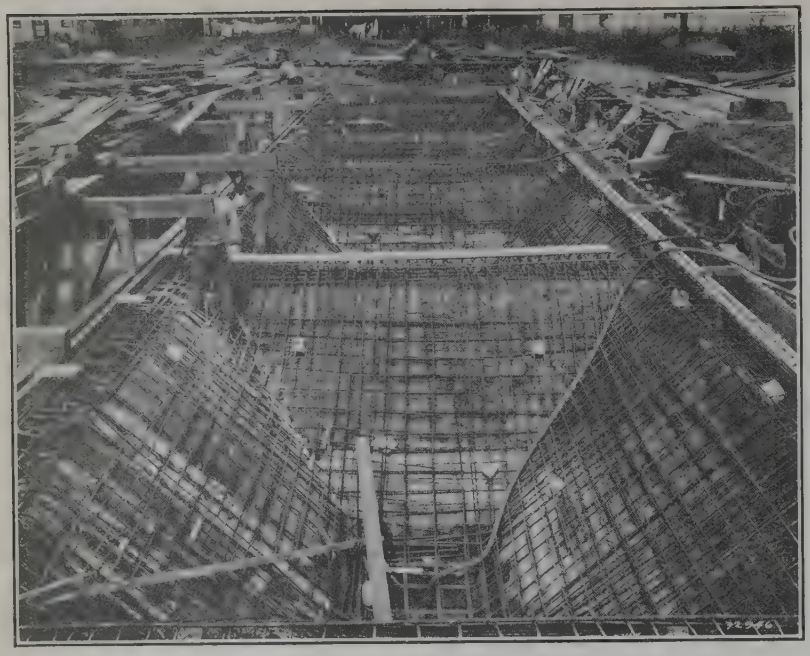
As is usual in residential towns within commuting distance of large industrial centers, the rate of flow in the sewers has definite hourly variations. This factor was given very serious consideration by the designers of the plant. To meet conditions, automatically controlled pumps will be installed in the main pump house to conform to the rate of flow in the sewers. These pumps, two in number, will have different capacities, and both will be the variable-speed type. The smaller pump has a minimum capacity of 200 g.p.m., which can be automatically increased in steps of 100 g.p.m., to a maximum capacity of 800 g.p.m. The larger of the two pumps will have a minimum capacity of 600 g.p.m., with a variable capacity by which the rate of flow can also be increased in steps of 100 g.p.m. to a maximum capacity of 1,200 g.p.m. Both pumps will have a depth increment of 3 in. against a 20-ft. head and will be controlled by variable-speed motors.

Automatic Control.—To effect economy in operation, the motors will be automatically controlled by a float in the sewers, and will require the attention of only one attendant, whose main duties will be to care for the moving parts, keeping them greased, oiled, and in good working condition.

When the influent reaches the main pump house, it is pumped to the hoppers of the septic tanks, through sherrardized V-notch weirs. Automatic valves control the amount of influent which each septic tank will receive, and will prevent the overloading of the tanks nearest to the pumps by the even distribution which they will effect. Once in the septic tanks, the sludge settles by gravity to the bottoms of the hoppers, whence it is pumped to the sludge drying beds above. In each hopper is sludge handling equipment for



General View of Construction Operations for Sewage Disposal Plant of Highlands, N. J.



View of Excavation Showing ¾-in. Steel Reinforcing for Sludge Hopper Construction

pumping the sludge to the drying beds above. This consists of a footpiece having a capacity of 300 g.p.m. of sludge, with a pipe submergence of 14 ft. and a total lift of 20 ft. The air consumption for lifting the sludge will be approximately 2 cu. ft. of air per cubic foot of sludge, but will not exceed this figure. The sludge equipment will be operated by a self-contained motor, operating a 3-in. portable diaphragm pump. Each sludge pump will be surmounted by a cast iron bell to effect an even distribution of the sludge over the sludge drying beds.

The sludge drying beds will consist of a layer of hard, durable, rounded gravel of high specific gravity, and on top of this will be placed a layer of clean sand of .30 to .50 millimeters, with a uniformity and coefficient of 3.50. The underdrain of these beds will be constructed of 8-in. glazed terra cotta half-tile connected to a cast iron drain, to allow the liquid from the drying sludge to flow into the effluent in the septic tanks.

The effluent will flow by gravity from the septic tanks through a vacuum solution manual feed chlorinator, having a maximum capacity of 200 lb. and a minimum capacity of 20 lb. per 20 hours. From the chlorinator it will flow through a 16-in. main to the outfall in the ocean—a distance of approximately 3,000 ft. To clear the channel of the Navesink River, which lies between the plant and the outfall in the ocean, the sewer will have a drop and rise of 25 ft.

The superstructure of the main plant will be of greenhouse construction to allow plenty of light and air for drying the sludge in the sludge beds.

Handling Excavation in Wet Ground.—In the construction of the septic tanks and main pump house, difficulty was experienced in keeping the excavations free of water. This was due to the proximity of the plant to the ocean and the formation of the soil. The top layer, from plus 4 ft. to minus 1.5 ft., consists of an old marsh with many fibrous roots. This layer cuts easily and remains firm after cutting. At minus 1.5 ft., clean, coarse sand is encountered fairly free from water at this point, but becoming more waterbearing down to minus 6.25 ft. Here the marl, because of its hardness and consistency, does not allow the water to drain off, and, as a consequence, forms a pocket for the water. This condition makes the lower part of the sand layer very wet; hence when excavations reached this point, the wet sand, with its tendency to slide, was a constant threat to the sides of the excavations.

Before actual digging started, a large sump hole was dug at the highest level of the ground, outside the foundation limits, to prevent the surface water from draining into the excavations. To keep the excavations as dry as possible, once digging started, 130 well points were driven with a water jet to minus 14 ft. The well points were spaced on 3 ft. centers and 4 ft. outside the foundation limits. They were connected to a 5-in. header by flexible hose. A Marlow centrifugal pump, having a capacity of 500 g.p.m. and operated by a 12-hp. Le Roy motor, was in turn connected to the header. The prime for this pump was maintained by a Marlow 3-in. diaphragm pump. The arrangement kept the excavations fairly free of water.

Prior to excavating for the hoppers of the septic tanks, 25-ft. piling with 10-in. butts was driven to minus 22.5 ft. The piling was yellow pine, calculated for a load of 10 tons. For each hopper 22 piles were driven with a drop hammer. The piling drove easily until the marl was reached at minus 6.25 ft., and from that point the driving slowed up noticeably because of the hardness of the marl. A water jet with a pressure of 100 lb. was tried as an aid to driving the piling, but this proved to

The 5-in. Header and Well Point Connections for Dewatering Operation

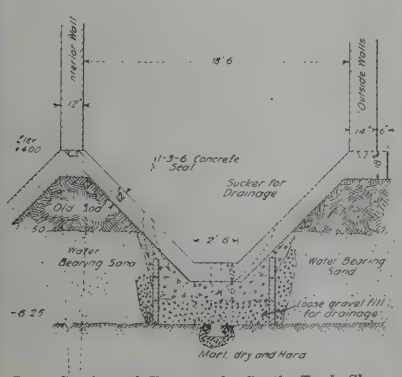
be of little aid in penetrating the marl. As a result, the piling was driven dry.

As the excavating proceded to a depth of minus 6.25 ft., no serious trouble was encountered; but when digging went beyond that depth, the sand still contained enough water to give serious trouble. The pumps, working continuously night and day for four weeks, could not remove this difficulty, as a consequence the sand, still fairly wet, had a tendency to slide into the bottoms of the excavations.

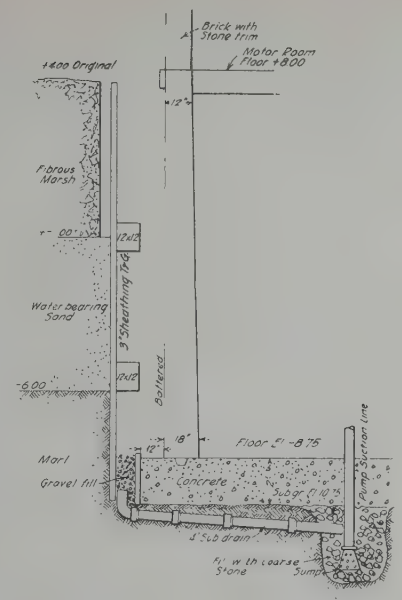
Method of Preventing Wet Sand Seepage.—To overcome this sliding action, several methods were employed, all proving more or less unsatisfactory until the expedient of using gravel was tried. In the pump house excavation, where a vertical cut was required, sheeting could be used, but on account of the 45 deg. angle of the hoppers, sheeting could not be employed here, and the problem of keeping the wet sand in place was more difficult.

For the pump house, 3x12 tongue-and-groove sheeting was driven to minus 14 ft., 2 ft. deeper than the cellar bottom. This sheeting was driven for a distance of 8 ft. through the hard marl with an Ingersoll-Rand CC-35 sheet pile drive, the air for which was supplied by an Ingersoll-Rand portable compressor. At minus 12 ft. the cellar bottom was reached, but in spite of the fact that the sheeting went to minus 14, the wet sand kept slowly oozing through. To stop this seepage, a 1-ft. trench was dug along the inside of the sheeting and was filled with gravel. A 4-in. sub-drain ran from the gravel to the center of the excavation, where it emptied into a sump hole. A suction line connected to a centrifugal pump was placed in the sump hole and then the hole was filled with gravel. This method succeeded in keeping the cellar bottom free from water.

Preventing Sliding of Wet Sand.—Obviously, because of the dissimilarity in construction, an entirely different method had to be devised, for stopping the sliding action of the wet sand in the hoppers. The method finally decided upon by Mr. Skinner, which proved successful, consisted in making a hole 2 ft. deep and 6 ft. across at



Cross Section of Hoppers in Septic Tank Showing Method of Sealing Bottoms



Cross Section of Pump House Foundation Showing Method of Draining Cellar Bottom

the bottom of each hopper. The sides of this hole were lined with 2x8 tongue-and-groove sheeting placed on edge, and laid parallel to the bottoms of the hoppers. Shallow holes were dug at the top and back of this sheeting and filled with gravel. As the weight of the gravel caused it to sink, more was added until the gravel extending from the top to the bottom of the sheeting formed a curtain between it and the wet sand.

A sucker line for draining was placed in the center of the hole and gravel to a depth of 6 in. placed around the sucker. The sucker, which operated continuously, drew off the water and kept the water level below the top of the gravel. It was in operation until after the concrete seal had been poured and had set. The seal consisted of a 1:3:6 mixture. It was poured to a depth of 6 in. on the layer of gravel and also along the sides of the hoppers to a height of 1.5 ft.

This seal effectually checked the seepage of the sand and water into the hopper bottoms. Work then proceeded rapidly, as no further difficulty was experienced from seepage. The walls of the hoppers were poured with a 1:2:4 mixture reinforced with steel bars. The weight of the steel used for each hopper averaged 2 tons.

Company Operates 31 Alabama Water Systems.—The Alabama Water Service Co., which recently acquired the properties of the Consumers' Water Co., in Alabama, now operates 31 water works in the states. The Alabama Water Service Co., is a subsidiary of the Federal Water Service Corporation, which through its subsidiaries furnish water for domestic and industrial purposes to numerous cities and towns throughout the country having a total estimated population of more than 2,380,000. Federal's properties are distributing more than 270,000,000 gal. of water a day through 5,350 miles of mains, not including recent purchases.

Some New Jersey Municipalities.—Two municipalities in New Jersey consist of golf courses, one is an airport, another has a population of 10, and a fifth is credited with 12 inhabitants.

Driving Piles with Sheeting Hammers and Portable Compressor

Collection and Utilization of Gases

Economic Phases of Use of Gases from Sewage Sludge

By DR. ANTHONY J. FISCHER
Engineer, The Dorr Co., New York

GASES produced by the digestion of sewage sludge have been collected and utilized since as early as 1907. Up until 1925, however, little thought had been given to the economic aspects of this problem. Then when various investigators demonstrated that with proper temperature and control, digestion capacities could be cut approximately in half there was a renewed interest in the collection of gas for sludge heating.

Amount of Gas Produced.—In general, laboratory experiments have shown that an average American domestic sewage will produce 530 c.c. of gas per gram of dry solids if thoroughly digested. Indications are that various physical and chemical factors do not affect this total production, although they do affect the rate of production. The chief controlling factors are temperature seeding, pH value, stirring, concentration, and character of sewage. Inasmuch as we are interested chiefly in the rate of gas production in actual plant operation, these factors are of vital importance. If, for example, a tank has sufficient capacity to take care of a 60-day supply of raw sludge containing 5 per cent total solids, with 75 per cent volatile matter, we could expect to obtain 90 per cent of the gas, provided we maintain a temperature of about 75° F., a pH value of about 7.5 and an amount of ripe sludge equal to at least 20 times the daily addition of raw slude on a dry solids basis. Lowering the temperature, pH value or amount of ripe sludge will cut down this percentage considerably. Stirring has a beneficial effect and will increase the rate of production.

Comparisons of daily production on a per capita basis mean very little because the amount of gas will vary with the strength of the sewage and the removal of suspended solids by the settling units. Taking an average domestic sewage containing 200 p. p. m. suspended solids, we can safely assume a 50 per cent removal for primary settling only, 75 per cent for a trickling filter plant and 90 per cent for an activated sludge unit. Under proper conditions, therefore, we should obtain a daily gas production of 0.64, 0.96 and 1.15 cu. ft. per capita, depending on the method of treatment.

Composition of Gas.—The composition of the gas will, of course, vary depending on the character of the sewage. Gas from material high in carbonaceous materials, such as screenings, will give a low methane content. The average gas, however, may be safely assumed to contain about 70 per cent methane, 25 per cent carbon dioxide, and 5 per cent nitrogen. As the heat value of the gas is directly proportional to the methane content, the heat value can be estimated to be 700 B. T. U.'s per cu. ft. This assumes the absence of hydrogen which is present only under abnormal conditions. Other hydrocarbon gases are present in so small amounts as not to have any appreciable effect.

At the present time nearly every tank with gas collection facilities is of the separate digestion type. As a rule, tight concrete covers for these tanks are favored as this type of construction allows covering with earth which is highly desirable during cold weather. They also insure against any loss of gas through leakage. Practically all the covers have a slight slope and have the underside submerged. This has the advantage of preventing the accumulation of gas in the tank and hazard of explosion; it also causes the scum in the tank to be submerged, under which conditions it digests more readily instead of forming a thick hard crust through which the gas has difficulty in escaping.

Gas Collection System. — Modern practice favors a gas collection system consisting of a gas dome, condensation trap, meter, flame trap and pressure relief trap for small installations. For large plants a gas holder might be desirable.

Considerable attention has been paid to the design of gas domes. In general, high separate seal domes are desirable because they prevent the loss of gas if for any reason the liquid level in the digestion tank is lowered, and they also lessen the chances of gas line clogging by scum rising in the dome. German practice favors the use of a scum rack or screen to prevent clogging by scum. It has been found, however, that these racks clog quickly and their use is questionable. The best method of eliminating this troublesome feature of gas collection is by draining off the scum through a line running to the dome. Spraying water through nozzles connected to the gas lines has also been tried, but was found to afford only temporary relief. Whether or not sprays are used, however, there should be connections available for flushing back the gas line between the condensation trap and the gas dome.

In cold climates insulation of the gas line is absolutely necessary; otherwise, freezing of condensate will cause clogging. The condensate should be collected and drained off periodically at the low point in the line before the gas enters the meter.

In order to prevent a possible backflash in the line, a safety flame trap should be provided. This trap should be located between the source of supply, whether it be a gas holder or the digestion tank, and the point of utilization. Two methods of accomplishing this purpose are in use: (1) A water seal, and (2) a wire gauge arrangement similar to a Davy safety lamp. It appears that either of these will afford adequate protection against explosions.

The pressure relief trap should be connected in front of the flame trap. It consists of an ordinary closed tank partially filled with water and connected so that when the gas pressure exceeds the submergence of the entrance pipe, it automatically by-passes through another pipe connected to the top of the tank. This will prevent the building up of pressure in the line should the use of the gas be discontainued. It is also of value where the gas is put to two separate uses, as the amounts sent to each point of utilization can be regulated by varying the submergence of the entrance pipe.

Utilization of Gas.—At the present time in this country, gas is being collected and utilized chiefly for sludge heating. This not only allows more economic construction by cutting the digestion capacity in half, but also does away with odor nuisance. In only one plant is there an attempt being made to heat the sludge in an Imhoff tank. All others are of the separate digestion type. At one plant, not yet in operation, the gases will be used as a source of heat in glass-covered sludge beds to facilitate drying during the winter months; at another, it will be used for burning screenings. In the past, the gas has been used successfully for heating small buildings. This is not being done at present to any great extent.

The use of gas for power has been shown to be entirely feasible by large scale tests. There is a renewed interest in this method of utilization, especially in view of the fact that the gas obtained is more than sufficient to maintain an average yearly temperature of 75° F. At a number of plants where the sewage is pumped, all or a part of the gas will be used for this purpose.

The disposal of activated sludge by digestion has also opened up another field for the use of the gas: that of operating the air compressors. This is already being done at the Sugar Creek plant at Charlotte, N. C. Gas being obtained from the digestion of combined raw and activated sludge amounts to about 30,000 cu. ft. a day and is used to run the compressors for about seven hours each day.

Hatfield estimated that 14 cu. ft. of gas obtained from the Imhoff tanks at Decatur would generate one brake horsepower hour. On this basis, figuring on 1.15 cu. ft. of gas per capita per day, 820 b. h. p. hours could be generated by the digestion of sludge from a contributing population of 10,000 Assuming that the power required for aeration were 25 h. p. per m. g. d., more than enough power would be available. In warm climates there would be a possibility of having sufficient gas both for sludge heating and for aeration.

Acknowledgment.—The above is a paper presented at the 11th Texas Water Works Short School.

Cost of Sewage Works Operations

Data for the Treatment Plant of Baltimore, Md.

By C. E. KEEFER

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THE keeping of accurate and detailed cost data of the maintenance and operation of sewage works is a matter of prime importance for many reasons. These records are of special value to the plant superintendent, as they enable him to compare one year's costs with another. Furthermore, where plans are being considered to replace a portion or all of the plant with other treatment units, a more logical decision can be reached if accurate operating costs are available for study and comparison. These costs serve a wider field if they are published, and thus become available to sewage works superintendents and engineers. In view of these facts it has been the policy for a number of years at the Baltimore sewage works to prepare detailed cost figures. Although the methods followed in keeping these records are essentially the same as for other municipal or private undertaking, the general principles involved will be briefly presented. Tables of segregated costs are given covering the operation of the Baltimore plant.

Generally speaking, there are two items which, when added together, give the total cost of sewage treatment. The first of these is the fixed charges, which include the interest on the original investment and the depreciation of the improvement. The second item, with which the sewage works operator is particularly concerned, covers operating and maintenance costs.

Interest and Depreciation Charges.—The first cost of a plant is usually known at the time it is put into operation. This cost should include not only the money paid contractors for construction expenses but also such items as the cost of the property on which the plant is built, engineering and architects' fees, administrative and overhead expense, discount on the sale of stock, and other preliminary expenses. In case it is impossible to obtain some or all of these expenditures the sewage works operator should prepare an estimate of the total cost of the plant. With this cost established, together with the rate of interest and the par value of the stock, which is sold to finance the project, it is possible to calculate the annual interest charge.

From time to time improvements—perhaps of a minor nature—will be made. The cost of these should be added to the first cost of the plant even though the funds allotted for the work were originally intended for operation and maintenance purposes.

To determine the annual depreciation charge it is necessary to assume some future date when the sewage plant will have to be rebuilt because of obsolescence or because of its deteriorated condition. The progress that has been made during the last five or ten years in sewage treatment would indicate that many sewage works will have to be rebuilt because of obsolescence rather than because their useful life has terminated. For this reason it becomes difficult to estimate depreciation charges. As indicated in Table I the useful life of the Baltimore sewage works has been assumed to be 33⅓ years. A considerable portion of the plant has now been in service for 17 years, and it is believed that a large part of it would give service for another 30 or 40 years. It is likely, however, that future advances in the science of sewage treatment will not justify continuance of the present method of treatment at Baltimore for that length of time. In fact, plans embracing extensive changes are now being prepared.

Calculating Depreciation.—With the useful life decided upon the next procedure consists of selecting the most desirable method to follow in calculating the depreciation. Several ways of determining this charge are available, such as the straight-line method, the diminishing-value plan and the sinking-fund plan. These three methods will not be discussed other than to say that each possesses certain advantages. It would seem most desirable to use the sinking-fund method for determining the depreciation of public improvements. This plan consists of setting aside each year a sum of money so that at the end of a predetermined time—the estimated life of the improvement—the sum total, including the accrued compound interest, will equal the first cost of the project less its scrap value. The annual installment, "*I*" (depreciation charge) necessary to set aside for a term of "*n*" years at an interest rate of "*i*" to provide a sinking fund "*S*" can be expressed by the formula

$$I = \frac{Si}{(1+i)^n - 1}$$

After the fixed charges have been calculated, it then becomes necessary to determine the annual running expenses of the plant.

Operation and Maintenance Charges.—The sewage works superintendent desires to know not only the total cost of operating his works but also the cost of running the various treatment units of the plant. This information can be obtained by assigning charge numbers to each phase of the operation, such as screening, grit removal, sedimentation, oxidation, sludge digestion, sludge drying, and maintenance of grounds. All money expended, both for labor and materials, can then be properly segregated. In order that the segregations may be intelligently made at those plants where electric power units are

Table I—Cost of Sewage Treatment at Baltimore

Year (1)	Average Sewage Flow M. G. D. (2)	Population Contributing Sewage[1] (3)	Total Cost of Plant (4)	Fixed Cost: Interest 4.1% Plus Depreciation 1.5%[2] (5)	Fixed Cost: Per M. G. of Sewage (6)	Fixed Cost: Per Capita per Year (7)	Operating Cost: Total (8)	Operating Cost: Per M. G. of Sewage (9)	Operating Cost: Per Capita per Year (10)	Fixed Cost and Operating Cost: Total (11)	Fixed Cost and Operating Cost: Per M. G. of Sewage (12)	Fixed Cost and Operating Cost: Per Capita per Year (13)
1921	46.62	536,952	$3,337,100	$186,877.60	$10.98	$0.348	$ 76,656.02	$4.51	$0.143	$263,533.62	$15.49	$0.491
1922	47.49	556,400	3,344,100	187,269.60	10.80	0.337	106,384.26	6.14	0.191	293,653.86	16.94	0.528
1923	48.17	578,755	3,496,000	195,776.00	11.14	0.338	103,983.21	5.91	0.180	299,759.21	17.05	0.518
1924	53.50	608,127	4,027,600	225,545.60	11.52	0.371	106,945.52	5.46	0.176	332,491.12	16.98	0.547
1925	55.09	647,080	4,257,800	238,436.80	11.86	0.368	108,048.90	5.37	0.167	346,485.70	17.23	0.535
1926	58.54	681,962	4,392,400	245,974.40	11.51	0.361	103,399.73	4.84	0.151	349,374.13	16.35	0.512
1927	59.62	702,827	4,584,000	256,704.00	11.80	0.365	104,418.00	4.80	0.149	361,118.00	16.60	0.514
1928	63.49	714,032	4,601,900	257,706.40	11.09	0.361	107,632.79	4.63	0.151	365,339.19	15.72	0.512

[1] Estimated as of July 1.

[2] Depreciation based on a useful life of 33⅓ years.

Table II—Cost of Operating the Baltimore Sewage Works

No.	Treatment Unit	1921	1922	1923	1924	1925	1926	1927	1928
1.	Bar screens	$ 5,469.19	$ 5,544.34	$ 4,571.48	$ 5,454.52	$ 5,790.73	$ 6,207.70	$ 6,119.19	$ 5,928.62
2.	Settling tanks	8,974.66	11,733.60	16,944.95	17,372.38	17,231.64	16,880.86	18,650.84	21,205.66
3.	Imhoff tanks	4,822.11	3,640.52	3,536.68	2,896.14	.....	.....	.....	.....
4.	Revolving screens	10,987.67	13,289.15	13,518.24	10,694.38	13,171.15	8,809.55	9,184.28	4,898.37
5.	Trickling filters	11,500.72	16,599.40	12,602.55	16,247.69	13,483.48	15,583.68	13,608.66	14,276.39
6.	Final settling basins	3,491.19	3,437.87	4,972.45	5,190.52	4,287.61	3,805.83	4,307.50	3,793.64
7.	Sludge digestion tanks	8,057.62	9,534.16	12,780.20	14,187.11	16,078.24	13,122.31	10,891.97	11,318.71
8.	Sludge drying beds	13,262.19	18,181.37	23,300.63	23,558.90	23,601.03	25,001.21	25,311.14	24,099.49
9.	Final sludge disposal	2,090.67	16,331.68	506.38	.....	.....	2,561.34	4,242.99	7,643.39
10.	Maintenance of grounds	8,000.00*	8,092.17	11,159.65	11,343.88	14,405.02	11,427.25	12,101.43	14,468.52
	Total	76,656.02	106,384.26	103,983.21	106,945.52	108,048.90	103,399.73	104,418.00	107,632.79

* Estimated.

used, wattmeters should be provided to register the power consumption at the various parts of the plant.

It is frequently desirable to keep operation and maintenance costs separate, with each of these items further segregated into labor and materials. Operation charges should include such items as labor required to clean sewage screens, to attend to the operation of settling tanks, to remove sludge from drying beds electric power used to operate sewage and sludge pumps, chlorine used for treatment purposes, chemicals and supplies. Maintenance charges are embraced in such items as labor and materials needed for repairs, the painting of buildings and the storage of materials and supplies.

It is of particular importance that daily records of the quantity of sewage treated be obtained, together with the approximate number of persons served, so that the cost per million gallons of sewage and the cost per capita per year can be calculated. The general character and strength of the raw sewage should be known, as the cost of treatment is dependent thereupon.

It often becomes difficult to decide whether the cost of certain work should be added to the first cost of the plant, or should be included in the maintenance charges. The circumstances surrounding each case must be known before a satisfactory decision can be made. Let it be assumed, for example, that a pump is purchased for handling sludge. If the plant had never been equipped with such a unit, the installation should be classed as a new improvement, and the cost incorporated in the first cost of the plant; if the pump replaces another unit of the same kind because the latter has worn out, the first cost of the plant remains the same and the cost can be charged to depreciation reserve, but if the above replacement were due to the existing pump being damaged, the cost should be added to the maintenance of the plant.

Cost of Operating the Baltimore Sewage Works.—The cost of operating the Baltimore sewage works from 1921 to 1928 is shown in Tables I and II. Table I gives both the fixed and the operating costs on a million gallon and a per capita basis. It is of interest to note that during this period the fixed costs have fluctuated over a narrow range from a minimum of $0.337 to a maximum of $0.371 per capita per year, a variation of about 10 per cent. The per capita operating costs have fluctuated more widely, from $0.143 to $0.191. The operating costs per capita reached a maximum in 1922, and since then they have been decreasing, due chiefly to a greater number of persons being served.

In Table II the costs have been segregrated under ten different headings. These costs, as well as those given in Table I, do not contain any salaries other than paid to the employees at the sewage works. Thus, general overhead is not included. The cost of superintendence, including the salaries of chemists, clerks, foremen, watchmen, and janitors is distributed over the ten items in Table II.

Since the principal item of expense in operating the plant is labor and supervision, the personnel and their salaries are given in Table III. There is usually little fluctuation in the number of employees except in the number of laborers employed to remove sludge from the drying beds and to maintain the ground drying beds and to maintain the grounds. With reference to the former group as many as three gangs are needed at times, with 10 men in a gang, exclusive of the foreman and the operator who drives the locomotive. During the spring and fall, however, one gang is sufficient. The maintenance of the grounds which consists mostly of cutting shrubbery and grass, frequently requires the services of from two to six men.

The cost data compiled at the Baltimore works have been of great value as a basis of comparison with the cost of other methods of sewage treatment, especially where these methods have been considered for adoption at the Baltimore plant. Similar costs, compiled at other sewage works, should prove useful to engineers and others who are interested in sewage treatment.

Acknowledgment.—The foregoing is taken from the July Sewage Works Journal.

Table III—Personnel of the Baltimore Sewage Works

Title	Number Employed	Salary
Supervising force		
Superintendent	1	$2,800 per year
Chemists	4	$1,600 to $2,500 per year
Clerk	1	$1,600 per year
General operating force		
Foreman	1	85 ct. per hour
Operating engineer	1	$1,800 per year
Sewage sampler	1	50 ct. per hour
Storekeeper	1	50 ct. per hour
Janitors	2	30 ct. and 45 ct. per hour
Watchmen*	2	45 ct. per hour
Laborers	12	45 ct. per hour
General maintenance force		
Machinists	2	75 ct. and 80 ct. per hour
Electrician	1	$1,900 per year
Carpenter	1	70 ct. per hour
Chauffeur	1	50 ct. per hour
Helpers, handymen, etc.	5	45 ct. and 50 ct. per hour
Bar screens		
Laborers*	2	50 ct. per hour
Settling and sludge tanks		
Laborers	10	45 ct. and 50 ct. per hour
Revolving screens and trickling filters		
Operating engineers	4	$1,500 to $1,600 per year
Laborers*	2	45 ct. per hour
Sludge drying beds		
Foreman	1	65 ct. per hour
Locomotive operator	1 to 2	50 ct. per hour
Laborers	10 to 22	45 ct. per hour
Final sludge disposal		
Crane operator	1	55 ct. per hour
Maintenance of grounds		
Laborers	2 to 8	45 ct. per hour
Total	69 to 88	

Note: Supervising force works 39½ hours a week. Remainder of personnel works 48 hours a week except as noted.
The salaries paid during 1928 totaled $89,186.55.
*Work 56 hours a week.

Field Chlorination of New and Old Mains

Practice at Baltimore, Md., in Disinfecting Water Pipe

By J. H. STROHMEYER
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IN conformity with advanced standards of sanitation generally prevailing, the Bureau of Water Supply, of Baltimore, has been disinfecting water mains immediately after laying and prior to placing them into service. This procedure, the value of which I was at one time skeptical, has been forced upon us by circumstances which indicate quite conclusively the necessity for such sanitary measures.

Five years ago the matter was brought forcefully to my attention when a main laid by a contractor was flushed and gave forth articles which were anything but conducive to purity. It was evident that the pipe, which had laid for six months along the side of an arterial highway, had received but a cursory inspection before installation. Such a condition demanded definite action and our water main chlorination policy was inaugurated at that time.

Contamination of Pipe in Yards and Field.—A number of bacteriological tests were made to determine the probability and extent of contamination in pipe stored in our yards and of pipe distributed in the field. Cultures made from samples taken from the pipe stored in the yard developed generally negative results in both gas formation and excessive counts.

It is a matter of some interest that the cultures from the pipe piled in a north and south direction were generally better than those from pipe piled in the east and west direction. This may have been the result of the first mentioned pipe being exposed to the ultra violet rays of the north light. Because of the numerous buildings in our pipe storage yard causing eddy currents, I am of the opinion that the prevailing winds could have had little bearing on our observed data. The cultures taken from the pipe distributed along the line of its proposed installation and having been exposed to contamination for varying periods of time were found to be almost uniformly bad.

The results of tests of samples taken later at various times corroborate the first findings and indicate that contamination occurs in the field.

Standard Treatment at Baltimore, Md.—A standard treatment was established, which has been carried out as consistently as possible, providing an application of available chlorine of 100 p.p.m. of water. In terms of weight this ratio is 0.6 lb., or 10 oz., of free chlorine per 100 cu. ft. of main volume to be disinfected.

For small mains from 6 to 10 in. in diameter, calcium hypochlorite is applied by the water pipe construction foreman during installation. Since about 33 per cent chlorine is available in this compound, the amount of lime applied is about 2 lb. per 100 cu. ft. Upon completion of construction the main is charged very slowly and allowed to remain so for 24 hours when it is thoroughly flushed.

Under certain conditions, chemical treatment of this type is not practical. For example, a main which has been open in a trench for some period of time and which has accumulated a deposit of mud or other earthy material, requires, first, mechanical purification in the removal of the material either by scraping, flushing or both. In such cases it is impossible for a normal dose of chlorine and water to penetrate the foreign masses. Since these are most likely to be contaminated, the mechanical cleansing becomes practically a necessity before chlorination.

Cost Is Slight.—Chlorine gas, which is obtainable in tanks of portable size, is easily applicable to water main purification. Modern production methods and the great quantities in which it is now manufactured for the use of water works and other trades make its cost reasonable. Whether used in the form of hypochlorite of lime or as a free gas, there is no question in my mind, but that its slight cost is more than justified in the security following its use. It costs 1 ct. a foot to disinfect a water main with hypochlorite of lime and 2 ct. a foot using chlorine gas.

The method of application is arbitrary and matters little so long as effective mixture with the water is obtained. The free gas lends itself very readily to this mixing and for that reason should be given prime consideration when an extensive program of water main purification is being considered.

Methods at Baltimore.—After some years of experimentation a very efficient method was devised and an experimental injector was designed and built at the Bureau of Water Supply in Baltimore. The injector depended upon pressure of chlorine in the cylinder to force the gas into the main. While it worked quite well on several small jobs, it was found that its capacity was not sufficiently great to allow efficient chlorination of greater volumes. Our latest development consists of a mixing valve, a supply hose, a discharge hose and incidental fittings. In detail, the apparatus is arranged as follows: The syphon connection on the mixing valve is attached by a rubber hose to the chlorine cylinder, the supply hose is connected between a corporation cock in the old section of main and the supply end of the mixing valve, a hand valve being inserted in that point to allow adjustment of the flow, the discharge hose carrying the water and chlorine mixture fastened to the discharge side of the mixing valve and the injector tube. The tube is inserted through a corporation cock into the newly laid main.

The operation of the apparatus is very simple. Both corporation cocks are open, the hand valve is opened slightly to allow a small jet of water to flow through the mixing valve; the chlorine valve is opened, after which the hand valve is opened to the fullest extent, creating a noticeable suction on the chlorine supply. The line valve separating the new and old portions of main is raised the desired amount to produce a turbulent flow through the new section. The degree to which this main valve is opened depends upon the size of the flushing orifice at the end of the new section.

Operations Involved.—This method of chlorinating combines three operations, the latter two of which are valuable to purification. The first of these is the initial charging of the main, the other two are flushing and chlorinating, thus combining mechanical and chemical purification. Since the concentration of chlorine of 100 p.p.m. produces a residual chlorine content quite noticeable by odor, a uniform dosage is applied until such time as in the opinion of the operator it has reached the desired ratio. At this time the main valve and the blow-off are both closed, the chlorine tank disconnected, the hand valve on the supply line closed, the injector withdrawn from the corporation cock, which is then closed, and the apparatus thoroughly washed by means of the supply hose. Despite this washing, it is practically impossible to prevent corrosion of the ¾-in. silver plated injector tube, which has to be replaced at frequent intervals. A new type of injector is now being experimented with, which is resistant to, or rather unaffected by, oxidation, it being a glass tube enclosed in a hard rubber or bakelite casing.

The chlorinated water is allowed to remain 24 hours, after which interval the main is thoroughly flushed and placed into service. For definite assurance that the main is free from chlorine, a sample is taken from the blow-

off and tested for free chlorine by the ortho-tolidin or starch iodide method.

Chlorinating Old Mains.—In chlorinating old water mains, our practice is similar to new main chlorination. A section of the old main is removed in order to determine the amount of tuberculation, the types of microscopic growth, and to observe the general physical condition. From this information it is possible to decide upon a course of action which will enable us to purify along the most efficient lines. Personally, I believe that most old mains should be scraped and cleaned before attempting chlorination. However, we seldom find it necessary to chlorinate an old water main.

Sterilization of water mains is not a possibility, or better, not a practicability because of conditions over which the agents have no control. Purification or disinfection is, however, quite possible, since the purpose thereof is the destruction of bacteria pathogenic to man. The degree of disinfection varies with the amount of oxidation which has taken place, which in turn is indexed by the amount of free residual chlorine. Therefore, contrary to what I feel is a more or less popular belief, free residual chlorine does not indicate a sterile main, but serves rather to indicate a factor of safety, since there is no absolute certainty that the chlorine has penetrated every cubic inch of the treated volume.

Table Showing the Amounts of Hypochlorite of Lime Necessary to Disinfect One 12-Ft. Length of Main

Diameter of main in inches	4	6	8	10	12
Ounces of hypochlorite of lime	0.34	0.75	1.33	2.09	3.01
Tablespoonfuls, hypochlorite of lime	½	1	2	3	4

Acknowledgment.—The foregoing is an abstract of a paper presented June 26 at the 49th annual convention of the American Water Works Association.

Odor Control at Sewage Disposal Works

Experiments in 1928 at New Jersey Plant

By JOHN R. DOWNES

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ODORS naturally divide themselves into two classes: local and migrating. Local odors are such as may emanate from exposed sewage solids about screens or where they may have been carelessly dropped by attendants, or grease cakes forming just above the water line of sedimentation tanks and baking in the hot sun. Such odors and those about small pump stations may be annoying close at hand, but certainly would not be noticeable 50 yards from the source.

Cleanliness and the use of a good deodorant such as Phinotas will overcome local odor difficulty, though care should be taken to choose a deodorant which has an odor not worse than that which we seek to overcome. By this I mean that a good honest ammoniacal, stale urine odor is much preferable to many of the compounds used about public toilets. However, some very pleasing effects may be secured by carefully selecting the proper compounds.

By migrating odors, I mean odors that travel more than 100 yards, and this may stretch to a mile or two under favorable conditions. This type of odor is occasionally carried by high winds, but is then dispersed, within a reasonably short distance, by the very wind that carries it. They become really troublesome under the peculiar atmospheric conditions which produce smoke flags. These conditions most often occur about dusk.

Smoke Flags.—Probably all have noted times when a trail of smoke from a bonfire will hang suspended in the air a definite distance from the ground and from any object which it approaches. The smoke does actually travel in a definite direction, but so slowly that its movement is not visible. Also, which is the crux of the situation, so slowly that it is not broken up by eddies, or dispersed on approaching an object in its path, but flows, ever so gently, around or over such object. Usually, if you observe these smoke flags, you will see that they do not actually touch objects in their path but pass around them at a definite distance. It is this condition which makes shrubbery screens useless as odor controls. When there is wind enough to give obvious movement to the air currents, the odor cloud is broken up by impingement against the shrubbery wall, but without such degree of velocity the screen is ineffective, since the analogous smoke flag is often observed to trail over an intervening forest and descend unbroken on the opposite side.

The chief offending compounds which migrate in this fashion from sewage disposal plants are hydrogen sulphide and its allies. It has been definitely shown that this gas is attacked by chlorine with the formation of substitution products with odors varying from "Medicated" (chloroform) to zero, according to the quantity of chlorine used.

Cost of Odor Control.—While the quantity of chlorine used for this treatment appears large when figured in parts per million, Lynn Enslow and Wm. J. O'Connell, Jr., have developed the idea that the peak of hydrogen sulphide production is almost always coincident with the afternoon peak of sewage flow and it is only necessary to apply chlorine on this peak and possibly during the early evening hours, when there is still some of the offensive gas being carried over from the settling tanks, and when atmospheric conditions are ideal for the formation of smoke flags.

For instance, at the Plainfield plant the rate of use of chlorine is 400 lbs. per day, but it is necessary to apply it only during four or five hours with a total daily consumption of 70 lbs. Under these conditions, and with chlorine procurable at 6c per pound the cost for odor control during six summer months approximates $700.

We treat only during the summer months because hydrogen sulphide is produced in troublesome quantities only during warm weather.

Odor Control by Partial Activation.—Treating 25 per cent of the settling tank effluent by the activated sludge process and then mixing this treated portion with the balance of the tank effluent, very effectively destroys the hydrogen sulphide odor. From the operator's point of view, this method is preferable to chlorine treatment, but even though we can secure our power free by making use of the gas from the digestion tanks, the carrying charges on the machinery installation for the activated sludge process, are greater than the cost of chlorine plus the carrying charges on the chlorine feed apparatus.

Age of Sewage and Temperature.—Whether we have simply local odors amenable to deodorants of the Phinotas type, or migrating odors requiring chlorine or activated sludge treatment, will depend largely upon the age of the sewage and its temperature. For time is a factor in the production of the troublesome hydrogen sulphide, the time necessary for its production in disturbing quantities being shortened as the temperature rises. Even though the sewage reaches the plant in a fairly fresh condition, hydrogen sulphide in odor producing volumes may develop in the settling tanks where these are larger than the minimum required for sedimentation.

Odors from Digesting Sludge.—Uncontrolled digestion of sludge with exposed surface is a prolific source of odor. However, with our present knowledge of optimum digestion conditions, there is little excuse for odors from this source. The floating covers used at the Plainfield plant effectively eliminate odors from this source by (a) preventing exposure to the atmosphere, (b) keeping all floating material submerged, in which case certain odoriferous compounds, otherwise formed, are not produced, (c) providing a perfectly safe means of collecting the gas generated, thus making it available for heating the digesting sludge to the optimum temperature.

Acknowledgment—The foregoing is a paper presented at the 19th annual meeting of the New Jersey Sewage Works Association.

Storage-Discharge Method of Sewer Design

Takes Advantage of the Full Value of the Storage Factor

By WM. R. MATHEWS
Engineer of Sewers, Bureau of Sewers, Chicago, Ill.

WHEN a system of sewers is designed by the rational formula the branches and upper part of the system have higher capabilities per acre than the lower parts, so that they flow but partly full during the rainfalls that fill the lower sections. If the lower sections be undersized the flow is restricted and the upper sections and branches fill. If there be sufficient storage in these parts of the system the entire system may prove adequate.

Sewers may be designed so that advantage may be taken of the full value of the storage factor by the application of what I will call the "storage-discharge" method, which may or may not be new. The computations necessary to apply the method are tedious, but by applying it to typical cases and comparing the results obtained with those by the use of the rational formula, sufficient data may be had for the modification of the rational equation, which may then be generally applied.

Basis of the Method.—What I have called the "storage-discharge" method of design is based on the proposition that during the time of concentration the total quantity of water entering a sewer system is equal to the quantity stored in it plus the quantity discharged at the mouth. Values may be given to this entering quantity, to the quantity stored, and the quantity discharged, and an equation may be written and solved to give the sizes of a sewer section by section, beginning at the upper end and working toward the outfall.

The first term of the equation is the quantity entering the sewer. This quantity is the product of the co-efficient C, of the intensity of rainfall I, of the area drained A, and of the time T'. The time T' is the time concentration less one half of the inlet time, it being assumed that, during the inlet time, the entering rate increases uniformly from zero to the full rate I. The entering quantity may be written $C\,I\,A\,T'$.

The second term of the equation is the storage. For the first section of the sewer it is the product of the length of the sewer and its cross-sectional area. For the second section of the sewer it is the product of the length and the cross-sectional area plus the storage in the first section. For the third and following sections it is obtained in the same manner.

The third term of the equation is the quantity discharged from the sewer. When the area drained is a rectangular one, with the sewer parallel with one edge, the quantity reaching the mouth of the sewer product $C\,I\,A$ and the discharge is therefore the product of the mean discharge and the time of concentration, or one half of $C\,I\,A\,T$. If the size of the sewer be reduced to take advantage of the storage the rate of discharge will increase uniformly as before until it reaches the full capacity of the sewer, and the sewer will then flow full for the remainder of the time of concentration.

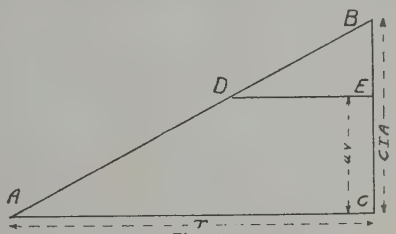

Fig. 1

The discharge of the sewer if reduced is shown by Fig. 1.

The base of the triangle ABC is the time of concentration T, the side BC is the product $C\,I\,A$, which is the rate of flow at the end of the time of concentration, and the area of the triangle, one half of $C\,I\,A\,T$, is the discharge at the mouth if the flow is not restricted. If the flow be restricted to take advantage of the storage the rate of discharge at the end of the time of concentration is represented by the line EC which is equal to av, the product of the cross-sectional area of the sewer and the velocity. The vertical ordinates of the line AD—DE represent the rates of flow during the time of concentration, and the area of the figure $ADEC$ the total discharge at the mouth. By similar triangles this area equals

$$T\left(av - \frac{a^2v^2}{2\,CIA}\right).$$

The equation for the design of a sewer by the storage-discharge method may now be written:

$$C\,I\,A\,T' = S + T\left(av - \frac{a^2v^2}{2\,CIA}\right)$$ in which

C = percentage of water reaching sewer.
I = intensity of rainfall.
A = area drained in acres.
or sewers.
S = storage, the cubical contents of sewer.
T = time of concentration in seconds.
a = cross-sectional area of sewer.
v = velocity.

Application of Methods.—I have applied this method to a district one-half mile wide containing 640 acres, with the sewer running lengthwise through the middle, with branches in two directions every 330 feet, each branch draining ten acres, using the following values:

$C = 25\%$.

$I = \frac{104}{t + 17}$ (t = time of concentration in minutes).

T = time of concentration in seconds = length of sewer divided by velocity plus inlet time.

Inlet time = 5½ minutes.

V = velocity in sewer, 3 feet per second.

For the branches the discharge is $T\left(av - \frac{a^2v^2}{2\,CIA}\right)$, as given before. For the main sewer this was slightly modified, T being reduced to $T - \frac{330}{3}$, it being assumed that water entered the main only by way of the branches, so that there was no discharge at the down-stream end of each section of the main for the first 110 seconds.

The method was first applied to the terminal section of a branch sewer draining 2½ acres, then in turn to 5, 7½, and 10 acres; then to the first section of the main, draining 20 acres, and so on to the last section of the main draining 640 acres. The results have been compared with those obtained by the application of the rational formula and are shown on the curve Fig. 2. This shows curves for the values of Q for from 0 to 640 acres as computed by the rational formula and as computed by the "storage-discharge" method. A curve is also given which gives the ratio of the values obtained by the two methods.

Comparison with Rational Formula.—It will be noted that the size (cross-sectional area) of a sewer for 20 acres by the storage-discharge method is 83 per cent of the size by the rational formula and that for 640 acres the size is but about 63 per cent, the ratio of sizes decreasing with the increase of the acres. The curves shown do not extend beyond 640 acres, but some preliminary computations on a rectangular area one mile wide indicate that a sewer to drain about 2,000 acres designed by the storage-discharge method would be but about one-half the size of one designed by the rational formula.

The values of C which I have sug-

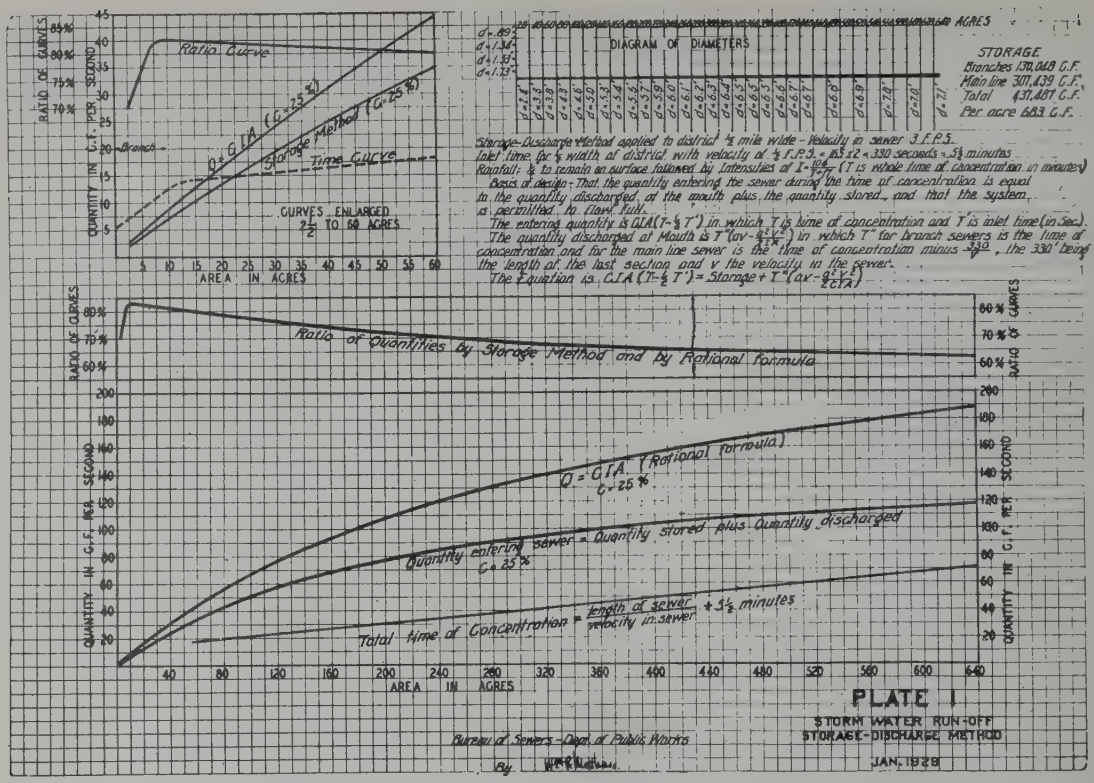
Ratio Curve
Storage Method (C=25%)
Rational Method (C=25%)
Time Curve
Branch
CURVES ENLARGED 2½ TO 60 ACRES
RATIO OF CURVES
QUANTITY IN C.F. PER SECOND
AREA IN ACRES
DIAGRAM OF DIAMETERS
STORAGE
Branches 130,048 C.F.
Main line 307,439 C.F.
Total 437,487 C.F.
Per acre 683 C.F.
Storage-Discharge Method applied to district ½ mile wide - Velocity in sewer 3 F.P.S.
Inlet time for ½ width of district with velocity of ½ F.P.S. = 165 x 2 = 330 seconds = 5½ minutes
Rainfall: ½ to remain on surface followed by Intensities of I = 100/(T+10) (T is whole time of concentration in minutes)
Basis of design - That the quantity entering the sewer during the time of concentration is equal to the quantity discharged at the mouth plus the quantity stored, and that the system is permitted to flow full.
The entering quantity is CIA(T-½T') in which T is time of concentration and T' is inlet time (in Sec.).
The quantity discharged at Mouth is T(av - g²v²/2CIA) in which T for branch sewers is the time of concentration and for the main line sewer is the time of concentration minus 330/v, the 330' being the length of the last section and v the velocity in the sewer.
The Equation is C.I.A (T-½T') = Storage + T'(av - g²v²/2CIA)
Ratio of Quantities by Storage Method and by Rational Formula
Q = CIA (Rational formula) C = 25%
Quantity entering sewer = Quantity stored plus Quantity discharged C = 25%
Total time of Concentration = Length of sewer / velocity in sewer + 5½ minutes
PLATE I
STORM WATER RUN-OFF
STORAGE-DISCHARGE METHOD
JAN. 1928
Bureau of Sewers - Dept. of Public Works

Fig. 2—Comparison of Calculations for Sewers by the Rational Formula and by the Storage-Discharge Method

gested for use in the rational formula of from 35 per cent to 45 per cent for "well built-up" areas and 60 per cent for areas approximately 100 per cent impervious are roughly equivalent to values of C in the storage-discharge formula of from 55 per cent to 65 per cent for "well built-up" areas and 85 per cent for areas approximately 100 per cent impervious. These latter values for C seem the more reasonable.

Acknowledgment.—The above is abstracted from a paper presented before the Western Society of Engineers.

Uses of Reclaimed Sewage at Grand Canyon

In an article on "Activated Sludge Practice in the United States" in our September issue, it was stated in the last paragraph on page 366, that "Chlorination of the effluent is carried out at Lodi, Pomona, Pasadena and Grand Canyon, in the first three instances to protect irrigated land from any germs of disease that might survive and at Grand Canyon for the drinking purposes in place of the restricted water supply."

This statement regarding the uses of effluent at the Grand Canyon was, of course, erroneous. As a matter of fact the reclaimed sewage at the Grand Canyon is used for industrial purposes only and every conceivable precaution has been taken to prevent any cross connection between the drinking water and reclaimed sewage water supply systems. A competent chemist is in charge of the treatment plant and frequent tests are made day and night to make sure that the reclaimed sewage is sterile at all times.

The following extract from a paper, "Sewage Treatment Plant at the Grand Canyon National Park," by H. B. Hommon, Sanitary Engineer, U. S. Public Health Service, the designer of the plant, brings out clearly the uses of the reclaimed sewage and the precautions that have been taken; it also gives some interesting information on the cost of operation:

Uses of Reclaimed Sewage.—At the present time the reclaimed sewage is used in stationary boilers for generating steam for heating purposes, and in the locomotives that haul passengers and freight trains on the branch line of the Santa Fe from Williams to the canyon; for cooling water for Diesel engines; for irrigating lawns around the hotel; and for flushing toilets in the public comfort stations in the El Tovar Hotel, Bright Angel Camp, railroad depot, and the Government automobile camp.

The force main from the treatment plant runs direct to the storage tank with only one branch taken off to supply cooling water for the Diesel engines. The entire distribution system from the storage tank is inclosed in vitrified pipes up to the outlets or fixtures where the reclaimed sewage is used. Beyond the vitrified pipe the uncovered distribution lines are painted red. The sewer pipe will prevent cross connections to fresh water lines. The pressure on the fresh water mains is greater than that on the reclaimed sewage lines. No valves, spicots, or any other openings are permitted on reclaimed sewage lines except where absolutely necessary. Accurate maps are kept up to date showing all the fresh water and reclaimed sewage pipe lines and no extensions or alterations of either piping system can be made without the approval of the superintendent of the park. With these limitations and precautions in distributing the reclaimed sewage, and the careful supervision given to the operation of the treatment plant, it is believed that it will be possible to use the reclaimed sewage indefinitely without any danger to the health of visitors to the park or of employees.

There has been no criticism by employees at the canyon who use the reclaimed sewage for generating steam or for any other purposes. The locomotive engineers vigorously opposed the use of "sewage" in passenger engines at first, but after a demonstration by an expert engineer they used the reclaimed sewage and found that it produced less scale than the fresh water obtained at the canyon.

All the reclaimed sewage is now being used for the purposes named above, and no others will be permitted, except possibly the washing of automobiles, under certain restrictions.

The treatment plant is operated under the supervision of a competent sanitary engineer who has two trained assistants.

Cost of Operation.—In considering the cost of operation, the fact should be kept in mind that the plant was designed and is operated to produce an effluent of the same degree of purity from a bacteriological standpoint as drinking water, and that every 1,000 gallons of reclaimed sewage that can be used in place of fresh water is worth $3.09. The cost data, therefore, should be considered in relation to water filtration rather than sewage disposal.

The average volume of sewage reclaimed daily during 1927 was 79,000 gal., and the itemized cost of treatment per 1,000 gal., was approximately as follows:

Electric current at 5 ct. per kilowatt:	
Operating blower	$0.20
Returning wash water	.003
Operating clarifier	.01
Lighting	.003
Labor for operating plant:	
2 operators and sanitary engineer	.177
Liquid chlorine, oil, grease, repairs to equipment, and extra labor	.009
Interest on investment (treatment plant only)	.086
Depreciation (treatment plant only)	.086
	.574

These costs would be reduced approximately one-half if the plant were operating at the capacity for which it was designed and if electric current were available at the commercial rate charged in cities; and the labor cost would decrease materially for plants treating large volumes of sewage.

Five Important Weather and Earthquake Cycles

Clay Varve and Tree Growth Records Employed With Electromagnetic Whirl Hypothesis

By HALBERT P. GILLETTE

A STUDY of annual tree-ring growth and of the annual clay laminae ("varves") deposited in ancient glacial lakes discloses five important weather cycles. For reasons given in "Municipal News and Water Works," and in "Engineering and Contracting," October, 1928, I have assigned these cycles to planets whose magnetic fields cause many sunspots when their north magnetic poles are pointed most directly at the sun. The magnetic fields of the sunspots, in turn, cause cyclonic storms on the earth, probably by producing a greater concentration of free electrons, or perhaps by releasing electrons from the atoms. The magnetic fields of the earth cause the free electrons in the air to rotate, thus producing both cyclonic storms and most of the general air currents that have hitherto been regarded as convection currents. Similarly electromagnetic whirls are caused in the molten interior of the earth.

The following are the lengths of five very important weather cycles, and dates of the last maxima:

Cycle Due to	Length of Cycle, Yr.	Last Maximum
Jupiter	11.214	1928.8
Uranus	81.15	1870.5
Neptune	161.4	1778.4
Planet A	322.4	1675.0
Planet E	3300	440 B. C.

In the article above referred to, I assigned the sunspot maximum of 1778 to Planet A (an unseen but clearly evident planet), but a more extended study of the radial growth of California giant redwoods and of clay varves has shown that Neptune caused that peak; and that the spot peak of 1675 was due to Planet A and not to Neptune.

Neptune's next sunspot peak will occur in 1939 at about the time that a Jupiter peak is due; and the next peak of Uranus will occur in 1951, also about the time of a Jupiter peak. In short, the conditions of 1778 and 1789 will soon be repeated, but with the added effect of Jupiter. Since the period of 1778-89 was one of unusual cold and precipitation, it is to be expected that the period of 1940-51 will be about the same. However, as will be shown in a later article, there is another factor that will tend somewhat to reduce the rainfall during 1940-51; but the 11-yr. period, 1951-1962, will be correspondingly wetter. Indeed this last-named period will probably be the coldest and wettest that has been experienced in North America since the 1778-89 period. This does not mean that all the years of these 11-yr. periods will be very wet, but only that the average wetness will be abnormal.

We have just passed through a relatively dry period of 22 years, and are now entering upon a relatively wet period of 33 years, because we are approaching sunspot peaks due to Neptune and Uranus, which have never failed to produce marked increases in the radial growth of the California and Arizona trees. The Arizona pines are particularly good recorders of rainfall, for they grow in relatively dry areas. Prof. Douglass has carefully measured their growth, and his charts and curves tell the rainfall story for every year back to 1395.

The clay varve measurements of Baron Gerard De Geer and of his one-time pupil, Prof. Ernst Antev, constitute an invaluable record of precipitation running back 18,000 years. The California redwoods give rainfall records for about 3,000 years. These varves and tree-ring records have been the main sources of information by which I have checked my theory as to the weather cycles caused by the planets named above. However, without a theory to guide me I doubt whether I should have found these cycles at all, except, of course, the well known cycle of 11.2 years. The other four cycles have far more important weather effects than that of Jupiter, but coming less frequently they have not been recognized as being regular cycles of the lengths above given.

The 3,000-year cycle is one of the most interesting, for it produces profound effects. The very cold and wet period that prevailed for a long time around 440 B. C. was followed by an exceedingly arid period for many years, centering about 1200 A. D., which was finally relieved by a wet cycle caused by Planet A, culminating in the very wet and stormy years of the 14th century, when planets A, Uranus and Neptune produced very severe weather.

There are three names that I venture to predict will ultimately stand very high in the history of meteorology, yet not one of the three is the name of a professional meterologist. I refer to Professors De Geer, Douglass and Huntington, named in the order of the dates of their first publications relating to weather cycles. Professor De Geer, the great Swedish geologist, began his study of annual clay varves more than 50 years ago, and soon found a periodic variation of about 11 years. Professor Douglass, an astronomer, began his study of tree-rings in 1904 and also soon found the 11-yr. cycle, together with an intermediate cycle of about 5 or 6 years. Professor Huntington, a geographer, at about the same time began publishing the results of his studies showing historic cycles of climatic changes. Then he followed this up with his measurements indicating a grand cycle in the growth of California redwoods, culminating about the fifth century before Christ, but he did not deduce the length of that cycle. He also found the 11-yr. cycle in the growth of these giant trees. Professor Douglass then made a more detailed study of California redwood growth, confirming Professor Huntington's general conclusions.

In spite of the clear evidence given by this remarkable pioneer work of De Geer, Douglass and Huntington, meteorologists have practically ignored it, and have not followed it up with any independent investigations of consequence. Hydraulic engineers, who are appliers of science rather than researchers, have not used the clay-varve and tree-ring data, because there was an evident complexity that made the data of little practical utility.

About three years ago, I began a determined attack upon this problem, with results that are already very satisfactory. I have found the cause of sunspots, and I have found a sunspot cycle due to every one of the eight visible planets, and to several planets as yet unseen but knowable by their effects on tree-growth; clay-varve thickness and the periodicity of geological epochs, periods and eras. (See the article above mentioned.) If skepticism arises as to any such knowledge about unseen planets, it should be remembered that no one has yet seen a molecule, to say nothing of an atom or an electron. Yet we confidently act upon atomic and electric theories—based upon the existence of those invisible units of matter. It will not be long, I think, before weather forecasters will take into consideration the effects of invisible planets, notably Planet A, the planet whose existence Lowell and Flammarion have independently predicted from astronomical considerations. I am now confident that it caused the sunspot maximum of 1675. There is a marked bulge about 1675 in the curve of tree growth of Arizona pines, and a series of such bulges prior thereto, about 322 years apart, on the curve of California redwood growth that I have plotted from the tables given by Professor Douglass. This latter curve extends from 1220 B. C. to 1914 A. D., giving the thickness of wood added each year.

In this connection it may be well to speak of the significance of the tree-growth maxima that occur about midway between the Jupiter sunspot peaks, that is, at sunspot valleys or minima. Douglass is the first to have mentioned this phenomenon; but he offered no explanation of it. At first it seemed to me likely that it is due to the periodic shifting of storm tracks, according to Kulmer's law; but more mature reflection showed that this could not explain the phenomenon.

According to the electron-whirl theory of sunspot and weather cycles, free electrons migrate on the earth under the influence of the magnetic fields of the sun, sunspots and planets. This migration changes the density of the free electrons in the atmosphere and in the earth, and results in changes in the intensity of the 12 permanent cyclonic whirls and of the numberless migrating cyclonic whirls. While sunspots, because of their magnetic fields, are important factors in causing such migrations of electrons, the magnetic fields of certain planets are much more important. Thus, when either one of Jupiter's magnetic poles is most inclined toward the earth, many cyclonic storms are generated on the earth. The same holds true of Uranus, Neptune and Planet A.

Incidentally this migration of electrons explains the existence of the flow of electrons from the earth to the air above it; for electrons migrate from the Heaviside layer (75 miles above the earth) downward toward the poles and thence through the earth toward the equator. In short, streams of rotating belts of electrons are maintained by magnetic pressure. The same sort of phenomenon occurs on the sun, and accounts for sunspots and for their periodicities.

Accordingly I adopted the hypothesis that although Jupiter's magnetic field produces few sunspots when its north magnetic pole points sunward, it does produce a concentration of free electrons in the earth's lower air and molten matter, so that both air-whirls and molten-whirls of greater frequency, intensity and size result. In short, Jupiter acts directly upon the earth when its north magnetic pole points earthward. Probably it also acts directly on the earth when its south magnetic pole points earthward, but this effect is so commingled with the effect of the sunspots that are then generated in great numbers as to make it difficult to determine the direct action of Jupiter.

No sooner had I reached this conclusion than I saw that there is a weather cycle of about 5.6 years (½ of 11.2) which intermediate rainy periods from a Jupiter peak is due to its north pole. These cycles are not precise as to time, there being a small swing on each side of the mean, because the earth travels in an orbit, cutting across the magnetic field of Jupiter twice each year. Jupiter is moving orbitally eastward and its magnetic poles are slowly rotating westward, which introduces some complexity, but a complexity that is rendered relatively simple when studied in the light of the facts just given.

In a chart of annual earthquake intensity, given by Edward Lynch in his "Solar Physics and Earthquakes," I find clear evidence not only of the 11.21-yr. cycle of Jupiter, but of the half period above mentioned. Huntington has commented upon the general tendency of rainfall maxima and earthquake maxima to concur, and this adds another bit of evidence in support of that theory. Huntington attributes such concurrence to the great changes in air pressure on the earth during stormy periods, whereas I attribute it to the molten-whirls in the earth that are electromagnetically generated by the same causes that generate the air-whirls.

The Encyclopedia Americana, under Disasters, cites 28 disastrous earthquakes and 38 great plagues and pestilences that have afflicted the world since the birth of Christ. I have listed all of these in the footnotes of Table I. Study discloses that great earthquakes have frequently occurred near the time of a Uranus maximum, and not infrequently near the time of a Uranus minimum magnetic effect. The same holds true of plagues. Since the latter are often caused by bacteria that are the hosts of mosquitoes, and since mosquitoes are more prevalent during rainy periods, there is a reason for the cycles of certain plagues. Perhaps all bacteria thrive best during rainy periods.

Of the 28 disastrous quakes, 13 occurred within 9 years of a Uranus maximum (Table I). Since the Uranus cycle is about 81 years, the probability that this would occur by chance is 1 in 3,594; for $2 \times 9 = 18$ years and $81 \div 18 = 4.5$; whence the probability of a single occurrence is 1 in 4.5. But there are 13 occurrences out of 28, whence by applying formula 23 given in "Probability and Its Engineering Uses," by T. C. Fry, we get a probability of 1 in 3,594.

By way of explanation, there is a probability that this event could occur 28 times out of 28 possibilities. The measure of this probability would be

$$\frac{1}{4.5^{28}} = \frac{1}{1{,}995{,}100{,}000{,}000{,}000},$$ which

is quite small. That is, this fraction measures the probability that the event would occur every time it had the chance, considering the occurrence as fortuitous rather than as demanded by physical law. If there were 28 opportunities for the quakes to occur, the chance of 28 occurrences would be measured by the fraction above.

According to hypothesis there were 28 chances for quakes to occur. According to fact there were 13 occurrences. The hypothesis states that conditions were such as to expect quakes.

If 28 quakes are expected to occur according to physical theory, and 28 occurrences are recorded, then we are likely to assume that $\frac{28}{28} = \frac{1}{1}$, and hence it is a certainly that these conditions absolutely cause quakes. But this reasoning is not quite true, because there is the possibility, as shown by the fraction, that the quakes could occur accidentally coincident with the theoretical or hypothetical favorable conditions.

So far as physical law and probability are concerned there is a difference in status if a quake occurs accidentally or if it is expected. Conditions could be favorable, according to physical theory, for the occurrence of a quake, yet the quake could occur accidentally while those conditions prevailed. The fraction, $\frac{1}{3594}$, measures the probability of getting 13 occurrences accidentally.

It is noteworthy that Jupiter assisted Uranus in producing many of the disastrous quakes. A Jupiter maximum occurred within a year of 10 of the 28 quakes. Hence $11.2 \div 2 = 5.6$; whence the probability of a single occurrence is 1 in 5.6; and the probability of 10 out of 28 is 1 in 80.

The two probability ratios thus deduced are much smaller than the actual probability ratio, for I have taken the extreme departure of an earthquake from the peak effect of each planet; and have made no allowance for the fact that many quakes occur near the time when a planet's south magnetic pole points most nearly sunward, which is at a sunspot minimum.

Huntington and Vischer, in "Climatic Changes," have conclusively demonstrated that earthquakes are most numerous at times of sunspot maxima; but this does not conflict with my inference that they are also abnormally numerous at times of sunspot minima.

The San Francisco quake of 1906 came a few days after an unusual eruption of Vesuvius and almost at the time of a Jupiter maximum effect, and 4 years before a Uranus minimum effect. San Francisco suffered from a severe quake in 1868, two years before a Uranus maximum, and near the time of a Jupiter minimum. A much greater shock occurred in 1872, at the time of a Jupiter maximum, in Owens River valley, about 200 miles east of San Francisco. None of the California quakes have been severe. The quake of 1906 did little damage in San Francisco. The damage was caused by the fire that followed it, as a result of the breaking of water mains. The quakes have their origin along certain well defined faults—where slippage occurs—as a result of the ascending molten-

Table I—Dates of Greatest Sunsport Effects Assigned to Four Planets

	(11.21 yr.) Jupiter A. D.	(81.15 yr.) Uranus A. D.	(161.4 yr.) Neptune A. D.	(322.4 yr.) Planet A A. D.
	0.7	4.9	3.0	.....
(a)	11.9	.....	.....	.....
	23.1	.....	.....	.....
	34.3	.....	.....	.....
	45.5	.....	.....	.....
	56.7	.....	.....	.....
	67.9	.....	.....	63.0
(b)	79.1	.....	.....	.....
	90.4	86.0	.....	.....
	101.6	.....	.....	.....
(c)	112.8	.....	.....	.....
	124.0	.....	.....	.....
	135.2	.....	.....	.....
	146.4	.....	.....	.....
(d)	157.6	.....	.....	.....
	168.8	167.2	164.4	.....
	180.0	.....	.....	.....
	191.2	.....	.....	.....
	202.5	.....	.....	.....
	213 7	.....	.....	.....
	224.9	.....	.....	.....
	236.1	.....	.....	.....
(e)	247.3	248.4	.....	.....
	258.5	.....	.....	.....
	269.7	.....	.....	.....
	280.9	.....	.....	.....
	292.1	.....	.....	.....
	303.3	.....	.....	.....
	314.6	.....	.....	.....
	325.8	329.5	325.8	.....
	337.0	.....	.....	.....
	348.1	.....	.....	.....
	359.4	.....	.....	.....
	370.6	.....	.....	.....
	381.8	.....	.....	385.4
	393.0	.....	.....	.....
	404.2	.....	.....	.....
	415.4	410.7	.....	.....
(f)	426.7	.....	.....	.....
	437.9	.....	.....	.....
	449.1	.....	.....	.....
	460.3	.....	.....	.....
	471.5	.....	.....	.....
	482.7	.....	487.2	.....
	493.9	491.8	.....	.....
	505.1	.....	.....	.....
	516.3	.....	.....	.....
	527.6	.....	.....	.....
	538.8	.....	.....	.....
	550.0	.....	.....	.....
(g)	561.2	.....	.....	.....
	572.4	573.0	.....	.....
	583.6	.....	.....	.....
	594.8	.....	.....	.....
	606.0	.....	.....	.....
	617.2	.....	.....	.....
	628.4	.....	.....	.....
	639.6	.....	.....	.....
	650.9	654.1	648.6	.....
	662.1	.....	.....	.....
	673.3	.....	.....	.....
	684.5	.....	.....	.....
	695.7	.....	.....	.....
	706.9	.....	.....	707.8
	718.1	.....	.....	.....
	729.3	.....	.....	.....
(h)	740.5	735.3	.....	.....
	751.7	.....	.....	.....
	763.0	.....	.....	.....
	774.2	.....	.....	.....
	785.4	.....	.....	.....
	796.6	.....	.....	.....
	807.8	.....	810.0	.....
	819.0	816.4	.....	.....
	830.2	.....	.....	.....
	841.4	.....	.....	.....
	852.6	.....	.....	.....
	863.8	.....	.....	.....
	875.1	.....	.....	.....
	886.3	.....	.....	.....
	897.5	897.6	.....	.....
	908.7	.....	.....	.....
	919.9	.....	.....	.....
(i)	931.1	.....	.....	.....
	942.3	.....	.....	.....
(j)	953.5	.....	.....	.....
	964.7	.....	.....	.....
	975.9	978.7	971.4	.....
	987.2	.....	.....	.....
	998.4	.....	.....	.....
	1009.6	.....	.....	.....
	1020.8	.....	.....	.....
	1032.0	.....	.....	1030.2
	1043.2	.....	.....	.....
	1054.4	1059.9	.....	.....
	1065.6	.....	.....	.....
	1076.8	.....	.....	.....
	1088.0	.....	.....	.....
	1099.3	.....	.....	.....
	1110.5	.....	.....	.....
	1121.7	.....	.....	.....
	1132.9	.....	1132.8	.....
	1144.1	1141.0	.....	.....
	1155.3	.....	.....	.....
	1166.5	.....	.....	.....
(k)	1177.7	.....	.....	.....
	1188.9	.....	.....	.....
	1200.1	.....	.....	.....
	1211.4	.....	.....	.....
	1222.6	1222.2	.....	.....
	1233.8	.....	.....	.....
	1245.0	.....	.....	.....
	1256.2	.....	.....	.....
(l)	1267.4	.....	.....	.....
	1278.6	.....	.....	.....
	1289.8	.....	1294.2	.....
	1301.0	1303.3	.....	.....
(m)	1312.2	.....	.....	.....
	1323.5	.....	.....	.....
	1334.7	.....	.....	.....
(n)	1345.9	.....	.....	.....
	1357.1	.....	.....	1352.6
	1368.3	.....	.....	.....
(o)	1379.5	1384.5	.....	.....
	1390.7	.....	.....	.....
	1401.9	.....	.....	.....
	1413.1	.....	.....	.....
	1424.3	.....	.....	.....
	1435.6	.....	.....	.....
	1446.8	.....	.....	.....
(p)	1458.0	.....	1455.6	.....
	1469.2	1465.6	.....	.....
(q)	1480.4	.....	.....	.....
	1491.6	.....	.....	.....
	1502.8	.....	.....	.....
	1514.0	.....	.....	.....
	1525.2	.....	.....	.....
(r)	1536.4	.....	.....	.....
	1547.7	1546.8	.....	.....
	1558.9	.....	.....	.....
	1570.1	.....	.....	.....
	1581.3	.....	.....	.....
	1592.5	.....	.....	.....
(s)	1603 7	.....	.....	.....
	1614.9	.....	1617.0	.....
(t)	1626.1	1627.9	.....	.....
	1637.3	.....	.....	.....
	1648.5	.....	.....	.....
	1659.8	.....	.....	.....
(u)	1671.0	.....	.....	1675.0
	1682 2	.....	.....	.....
(v)	1693.4	.....	.....	.....
	1704.6	1708.1	.....	.....
	1715.8	.....	.....	.....
(w)	1727.0	.....	.....	.....
	1738.2	.....	.....	.....
(y)	1749.4	.....	.....	.....
	1760.6	.....	.....	.....
	1771.9	.....	1778.4	.....
(z)	1783.1	1789.3	.....	.....
	1794.2	.....	.....	.....
	1805.5	.....	.....	.....
	1816.7	.....	.....	.....
(aa)	1827.9	.....	.....	.....
	1839.1	.....	.....	.....
	1850.3	.....	.....	.....
	1861.5	.....	.....	.....
(bb)	1872.8	1870.5	.....	.....
(cc)	1884.0	.....	.....	.....
	1895.2	.....	.....	.....
(dd)	1906.4	.....	.....	.....
	1917.6	.....	.....	.....
	1928.8	.....	.....	.....
	1940.0	.....	1939.8	.....
	1951.2	1951.7	.....	.....
	1962.4	.....	.....	.....
	.....	.....	.....	1997.4

(a) Earthquake destroyed Ephesus, 17 A. D.
(b) Pompeii destroyed by earthquake and eruption of Vesuvius in 79 A. D. Great plague in Rome in 80 A. D.
(c) Earthquake destroyed Antioch, 115 A. D.
(d) Earthquakes destroyed 150 towns in Asia and Macedonia in 157 A. D. Rome stricken with plague, 167 A. D.
(e) Rome plague stricken again, 250 A. D.
(f) Great Britain plague stricken, 430 A. D.
(g) Earthquake killed thousands in Constantinople, 557 A. .D
(h) Earthquakes caused terrible loss of life in Syria, Palestine and Asia, 742 A. D. Plague killed 200,000 in Constantinople, 746-9 A. D.
(i) Earthquake destroyed Constantinople, 936 A. D.
(j) Plague killed 40,000 in Scotland, 954 A. D.
(k) Severe plague in Ireland, 1172.
(l) Earthquake killed 60,000 in Cilicia, 1268.
(m) Greatest English earthquake, 1318.
(n) Plague ("black death") swept Europe, 1340.
(o) Plague ("frightful mortality") in Europe, 1362-79; and "the fourth pestilence" in Ireland, 1383.
(p) Earthquake killed 40,000 in Naples, 1456.
(q) Plague ("sweating sickness"), 1485.
(r) Earthquake killed 30,000 in Lisbon, 1531.
(s) Plague killed 30,000 in London, 1603-4.
(t) Earthquake killed 70,000 in Naples, 1626; plague killed 35,000 in London, 1625; and 60,000 in Lyons, 1632.
(u) Earthquake killed 80,000 in Shamazi, 1667; plague killed 400,000 in Naples, 1656; and 10,000 in London in 1664-5.
(v) Earthquake killed 100,000 and destroyed 354 towns in Sicily, 1693; plague killed 60,000 in Marseilles, 1720.
(w) Earthquake killed 100,000 in China, 1731.
(y) Earthquake killed 18,000 in Lima and Callao in 1745; 50,000 in Lisbon, 1755; "awful plague" in Syria, 1760; "Putrid fever" in France, 1773.
(z) Earthquake killed 40,000 in Cuzco and Quito, 1797. Plague killed 20,000 in Smyrna, 1784; 250,000 at Suez in 1799.
(aa) Earthquake killed 20,000 in Aleppo, 1822; "terrible plague" in Asia Minor, Palestine and Greece, 1814; in Calcutta, Bombay, Siam (Asiatic cholera), 1817-18; cholera in Tunis, 1819-22; cholera in Europe and America, 1831-2.
(bb) Earthquake killed 10,000 and destroyed many towns in Kingdom of Naples, 1857; killed 25,000 in Peru and Ecquador, 1868 (San Francisco suffered severely, 1869); killed many in Guatemala, 1874 (Great shock in Owen's River Valley, Calif., 1872). Cholera killed many in Europe, 1865.
(cc) Earthquake devastated Java, 1883 (Krakatoa exploded, 1883); Charlestown quake, 1886; great shocks in southern Europe, 1887. Yellow fever killed many in America, 1878; cholera raged in Europe, 1884-5, and again in 1892.
(dd) Earthquake at San Francisco, April 18, 1906; quake in southern Italy killed 150,000 in 1908.

Table II—Dates of 28 Sunspots Maxima, Jupiter's Max. Magnetic Solar Effect, Auroral Max., Etc.

Jupiter Cycle (11.21 yr.)	Sunspot Max. of Smoothed Curve	Auroral Max.	Big Wine Harvests	Big Hail-storms
1614	1615	1620	1616	1617
1626	1626 (U)	1629	1624	1630
1637	1639	1640	1637	1640
1648	1649	1647	1648	1649
1659	1660	1661	1657	.....
1670	1675 (A)	1677	1678	1676
1682	1685	1683	1686	.....
1693	1693	1690	.....	1688
1704	1705 (U)	1707	1704	1704
1715	1718	1719	1718	1720
1727	1727	1730	1727	1731
1738	1738	1739	1737	1740
1749	1750	1748	1748	.....
1760	1761	1760	1762	1762
1771	1769	1772	1775	1770
1783	1778 (N)	1778	1782	1780
1794	1788 (U)	1788	1790	1788
1805	1804	1804	1804	1804
1816	1816	1818	1819	1819
1827	1829	1829	1829	1828
1839	1837	1840	1837	1839
1850	1848	1850	1848	1848
1861	1860	1860	1860	1859
1872	1870 (U)	1870	1870	1869
1884	1883	1883	1883	1883
1895	1894			
1906	1906			
1917	1917			

Note: A=Planet A; N=Neptune; U=Uranus. The last three columns are given by Fritz.

whirls which behave like ascending cyclonic air-whirls.

Table II gives the dates that I have assigned to the maximum sunspot effect due to Jupiter, and in the next column are the dates that Wolf assigned to sunspot maxima; then follow dates of maxima assigned by Prof. H. Fritz (see "Monthly Weather Review," October, 1928, for a translation of his remarkable article published in 1893) to aurora, wine harvests and hail-storms. His dates of auroral maxima do not always agree exactly with those in the Encyclopedia Britannica, under Aurora, but the differences are immaterial for present purposes. Note the remarkable concurrence of the dates of maxima in the five columns of Table II, bearing in mind that 6 of the 28 sunspot peaks are due to the planets Uranus, Neptune and A, as per Table I. The 22 remaining sunspot maxima find agreement, within a year, in 15 instances.

Since any single instance of such agreement would occur by accident only once in 5.6 times, the occurrence of 15 out of 22 such agreements would be accidental only once in 3,881,455 times, according to the probability formula above cited. This alone would serve to establish the substantial correctness of the Jupiter spot cycle of 11.214 years, but I have established with vastly greater conclusiveness by tracing it back more than 3,000 years in the California redwood rings and 16,000 years back in the clay varves. By aid of the Jupiter, Uranus, Neptune and Planet A cycles, I find that the zero year on Professor DeGeer's chart is 6,764 B. C., and the year 3,000 on Professor Antev's varve chart is 12,449 B. C.; and the zero year on Reed's varve chart is 12,651 B. C. Professor De Geer had previously correlated Reed's American varves and some of Antev's American and Canadian varves with his (De Geer's) Swedish varves, and had expressed the hope that his varve dates would eventually be correlated with the dates of the rings of the California redwoods. He had estimated that his zero year was 6,800 B. C., and I find his estimate to be only 36 years away from the truth.

Professor De Geer has accomplished one of the most remarkable feats in the history of geology, for he has precisely correlated events of the last glacial epoch in Europe, America, Iceland, Argentine and India, by means of clay varves. He has shown fully 80 per cent agreement as to annual changes in thickness of varves. Since the chance is 1 in 2 that two sets of varves will agree by accident, it follows that if 15 successive agreements occur (and this happens very frequently) there is only 1 chance in 2 raised to the 15th power, or 1 in about 36,000, that such a concurrence is accidental. Occasionally 30 or more successive concurrences are to be seen on De Geer's charts, which could not occur by accident once in a billion times. The evidence is thus seen to be overwhelming that De Geer has effected a coordination of the clay varves in five areas that are widely separated; and this, I maintain, is one of the most remarkable achievements in the history of geology. I believe that it is also destined to have a profound effect, not only on meteorology, but on astronomy. For more than half a century this remarkable man has been making and gathering clay-varve measurements; but not until four years ago did he succeed in thus tying together the ice-age chronology of Europe and America. Even yet his great achievement is known by comparatively few scientists, and scarcely at all by the public. Such is too often the slow coming of merited fame.

Automatic Chlorination

Results of a Year's Experience at Concord, N. H.

By PERCY SANDERS
Superintendent of Water Works, Concord, N. H.

ON account of the source of supply being a surface supply and therefore liable to to possible contamination, the water board was advised by Metcalf & Eddy, consulting engineers, the New Hampshire State Board of Health concurring, to chlorinate the water. It was voted by our water board to carry out these recommendations and Metcalf & Eddy were authorized to submit a plan for the installation of a chlorinating plant. Owing to the good record which the water has shown in the way of sanitary and chemical analyses during the 57 years that it has been in use, it was decided that a comparatively minimum in amount of chlorine should be used.

The flow varied from 500,000 gal. to 6,250,000 gal. per day. An automatic type machine was recommended and installed in the fall of 1928 and has now been in operation practically a year.

The machine was furnished by Wallace & Tiernan Co., Inc., and is their Type ASVM automatic control vacuum feed chlorinator with an Ortho-Tolodin testing outfit.

Before the type of machine was decided upon, tests were made of the range of the differential heads on the Venturi and it was found that they varied from .4 ft. to 5.82 ft., or a ratio of 1 to 14.5.

The equipment is placed in the gate house, a small room having been built for it, and the water is chlorinated after passing through the screens.

Rate of Application.—Four meter tubes were furnished which permit the chlorine to be applied at the rate of 30 lb. per 24 hours; 24 lb. per 24 hours; 17 lb. per 24 hours; and 15 lb. per 24 hours, respectively. When we first started the machine we used the 17-lb. tube, which gave a dose of 2.8 lb. per million gallons; later we changed to the 15-lb. tube, which gives a dose of 2.5 lb. per million gallons, or .33 part per million.

The pressure on the line used to carry the chlorine into the water is 33 lb. and the amount of water used to operate the machine in 24 hours is 6,000 gal., or approximately 2,200 gal. for each million gallons chlorinated.

The Ortho-Tolodin test is made a short distance below the Venturi meter at intervals to ascertain if any residual or free chlorine is present, and while we always get a residual at this location, in making the same test at the pumping station we get none at all, showing that all chlorine has been absorbed.

How Chlorinator is Operated.—The chlorinator is operated by the throat and inlet pressures from the Venturi meter located 66 ft. from the machine, which differential pressure is transmitted 22 ft. to a differential convertor. The convertor changes the differential pressure to a vacuum which operates the chlorinator, the convertor being 44 ft. from the chlorinator and 22 ft. below it in elevation.

The operation of the machine was put under the charge of one of our permanent men who was carefully drilled in the care of it by Mr. Hart of Wallace & Tiernan Co., Inc.

The machine is visited four days a week to weigh the chlorine and check it up.

In the winter months we have a little difficulty in keeping the chlorine, chlorine tank and the room itself in an even temperature. Heat is supplied by an ordinary oil heater with reservoir connected by a small pipe to a 10-gal. tank, the flow line of which is at same level as the burner.

The vacuum line leading from the differential convertor to the machine has to be closely watched and drained as condensation will collect and prevent chlorination.

A small bottle of ammonia is kept to detect leaks in the equipment and a gas mask is kept just inside the main door of the gate house for emergency use in case of bad leaks.

We purchase the liquid chlorine from Brown & Co. of Berlin, N. H., who manufacture and use great quantities of it in connection with their bleaching processes.

The machine was in operation for several months before the fact was made public and during that time no complaints were received at the office of any unusual taste or odor in the water.

However afterwards, the case was different for a while; discoloration was noted on glassware, one or two persons had boils which they thought could be attributed to the chlorine and many people thought that the water had tasted queer for some time but hadn't known what the trouble was; we even had communication by mail assuring us that some had detected the change in the water several weeks before.

Everything is quiet now; we are chlorinating regularly and continually and no one notices the difference in the ordinary course of events; occasionally some solitary consumer will return from a vacation and inquire if the water from pipes unused for a month or two tastes and smells queer from the chlorine, but these complaints seem to be the only reminder of the change. There has been no marked improvement in the health of our citizens, but we rest secure that we are doing our best to give our community a clear and sterile water.

Acknowledgment.—The above is an abstract of a paper presented Sept. 18 at 48th annual convention of the New England Water Works Association.

Court Decisions on Sanitary Matters

Recent Rulings of Supreme Courts of Various States

Discharge of Sewage by Borough in Manner to Overflow Land Enjoined.—(Pennsylvania Supreme Court; Freedman et al. v. Borough of West Hazleton, 146 A. 564; decided May 13, 1929.) The borough of West Hazleton discharged sewage, at a certain place in the borough, into an open ditch. This ditch extended over plaintiffs' land to a creek. The polluted fluid spread, at various points along the ditch, over the land of plaintiffs and caused the emission of offensive odors which created inconvenience and unhealthful conditions to families living along the ditch within the borough. In an injunction suit brought by the plaintiffs, whose land consisted of plotted building lots which were suitable and available for residential purposes, the trial court found the above facts. It was also proved that the sewer system, at the point where the sewage entered the ditch, was wholly inadequate and insufficient to prevent the discharge of the polluted waters upon the plaintiffs' property. The trial court concluded that there was a public and continuing nuisance and granted the relief prayed for by the plaintiffs. On appeal by the defendant borough, the supreme court affirmed the lower court's decree, saying that "The facts in this case and the law applicable to them fully support the findings and final decree of the court below."

Regarding the claim, put forth by the borough, that it had a prescriptive right to the use of the ditch over plaintiffs' land, it was held by the supreme court that such claim had no application. The court stated that, although the ditch had been openly used for that purpose since 1902, that fact constituted no defense to a proceeding by an individual for the removal of an unlawful nuisance which developed in later years from such use, and that "the right to maintain a public nuisance can not be acquired by prescription."—Public Health Reports, Aug. 16, 1929.

Provisions of Ordinance Concerning Removal of Garbage Upheld.—(Oregon Supreme Court; Spencer et al. v. City of Medford et al., 276 P. 1114; decided April 23, 1929.) The city of Medford, by ordinance, declared it to be unlawful and punishable by fine or imprisonment for any person, firm, or corporation, other than a certain named corporation, to collect, gather, or haul over the streets of the city any garbage. The plaintiffs, in a suit to restrain the enforcement of the said ordinance, alleged that they were under contract with certain hotels, cafes, and restaurants to purchase and remove the garbage of such establishments; that they removed such garbage in a sanitary manner to places outside the city; and that such garbage was there used by them as feed for hogs. The plaintiffs claimed that the ordinance created a monopoly and was class legislation. The conclusion reached by the supreme court was that the city had authority to pass the ordinance in question and that the provisions thereof relative to garbage were reasonable.—Public Health Reports, Aug. 2, 1929.

City's Sewage Disposal Plant Not Enjoined.—(Texas Court of Civil Appeals; City of Wylie et al. v. Stone, 16 S. W. (2d) 862; decided April 10, 1929.) An action was brought against the city of Wylie and its mayor and aldermen to enjoin the operation of the city's sewage-disposal plant and to abate same, on the ground that its operation was a public and private nuisance. The jury's findings justified the conclusion that the plant as operated was a nuisance. The jury also found that the plant could have been located and operated in a practical manner on another site that would not have caused injuries to others similar to those inflicted on plaintiff; that plaintiff's land was depreciated in market value $5,000; and that the city would suffer $8,000 loss if an injunction were granted. The trial court abated the plant as a nuisance, enjoining the defendants from operating same at the location complained of. On appeal the judgment of the trial court was reversed by the court of civil appeals.

One of defendants' contentions was that, the legislature having authorized the governing authorities of the city to locate and establish the sewage plant, the nuisance, if any resulted from its operation, was legalized. The appellate court, however, held that the nuisance complained of did not belong to the category of those legalized, but, in a proper case, could be enjoined.

Another contention of defendants was that the trial court had erred in not directing a verdict in their favor because the evidence failed to show the existence of a nuisance, but this was overruled, for the reason that the jury's findings justified the conclusion that the disposal plant as operated was a nuisance.

In passing on another point raised by the defendants the court of appeals decided that "the jury should have been required to find in substance whether or not, under all the facts and circumstances, there existed a reasonable necessity for the location of the disposal plant at the point selected."

It was also contended that the plaintiff was not entitled to injunction relief as a matter of right, but should have been relegated to his action for damages. In discussing this phase of the matter the court said:

> It does not follow that every nuisance will be enjoined; courts will consider the equities pro and con. Ordinarily, where there exists an adequate remedy at law, a nuisance will not be suppressed by injunction; especially is this true in cases of the nature of the one under consideration, where the interest and convenience of an entire community is involved as against a private or personal inconvenience or loss that may be measured in dollars and cents.* * *
>
> One of the major functions of a municipal government is to insure proper sanitation and preserve public health; to this end the law, by express provisions of the statute and by many implications therefrom, has committed to governing authorities of cities, such as Wylie, the duty of establishing and operating sewer systems. They are authorized to purchase necessary lands, either within or without the city limits (art. 1108, R. S. 1925), and, when necessary, may acquire lands by condemnation proceedings (art. 1109b, R. S. 1925). Therefore, wherever these authorities act the presumption will be indulged, until overcome by a preponderance of evidence, that they acted in good faith, with due regard to the rights and interest of all concerned, and found a reasonable necessity for making the particular location. Courts are not authorized to substitute theirs for the judgment of authorities whom the law has clothed with exclusive authority to act, and their discretion, when exercised, should not be disturbed except in a clear case of abuse, which we do not find committed in this case.—Public Health Reports, July 12, 1929.

Garbage-Removal Ordinance Upheld and Refusal of Garbage-Removal Permit Sustained.—(Ohio Supreme Court; State ex rel. Moock v. City of Cincinnati et al.; Moock v. Same, 166 N. E. 583; decided May 1, 1929.) An ordinance of the city of Cincinnati provided as follows:

> That no person shall remove or carry in or through any of the streets, squares, courts, lanes, avenues, places, or alleys * * * any house dirt or house offal, animal or vegetable, or any refuse substance, from any of the dwelling houses or other places of the city. * * * unless the owner of the same shall have procured a permit so to do * * * prescribing the terms and conditions as may be deemed essential to the health and interests of the city. Provided, however, the provisions hereof shall not apply to any contractor with the city in relation to garbage.

The city contracted with a company for the collection and disposal of the garbage of the city for a 5-year period. The relator, who had contracts with various hotels, restaurants, and eating places to remove their garbage, was refused a permit to remove such garbage through the city. The relator owned a stock farm and utilized the garbage as food for animals. In actions instituted by him to compel the issuance of a permit and to enjoin interference with his removal of garbage through the city streets he attacked the above ordinance as being violative of both the State and Federal constitutions. The objections raised against the ordinance were that it denied the right of individual contract and conferred special privileges upon the contractor with the city, thereby creating a monopoly with respect to the garbage contract; that it permitted property to be taken

with compensation; and that the relator was denied the equal protection of the laws. The action of the city manager in refusing a permit to relator was challenged on the ground that his refusal was arbitrary and based upon mere whim and caprice, and it was contended that the city, having prescribed no conditions upon which permits should be granted, left their determination to the city manager and thereby invested him with legislative power. The supreme court decided that no rights of the relator, under either the State or Federal constitution, were violated by the ordinance or by the city manager's refusal to issue a permit thereunder.—Public Health Reports, July 19, 1929.

Sand and Gravel Requirements for Filters

Results of Investigations by National Sand and Gravel Association

FILTER sands have been found, from experience and laboratory investigations, to be required to possess fairly definite characteristics as to mineral composition, size and grading. They must be able to withstand the disintegrating influences of water, with which they are constantly in contact, and must be properly graded to insure efficient operation.

Sand Requirements.—Experiments have shown, according to Turneaure and Russell in "Public Water Supplies," that fine sands are considerably more efficient in removing bacteria than coarser sands and that within certain limits of size little difference in filtering efficiency is found. Also, finer sands cause a steadier and more uniform action over the filtering area, and disturbances due to scraping the filter are less likely to occur. On the other hand, the finer sands become clogged sooner than coarser ones and therefore involve more expense in cleaning. Allen Hazen in the paper, "Water Filtration at Washington, D. C.," which appeared in the Transactions, Am. Soc. C. E., Volume 57, 1906, page 326, under the authorship of Hazen, Allen and Hardy, established two factors to control the average size and uniformity of filter sands, which have come into general use. These are the "effective size" and the "uniformity coefficient."

Table I—Grading Requirements for Filter Sands Used by Different Cities
Information furnished by Sanitary Divisions of the various cities during 1928

City	Effective Size MM.	Uniformity Coefficient	Maximum Size Sieve Opening MM.	Minimum Per Cent Passing	Minimum Size Sieve Opening MM.	Maximum Per Cent Passing
Atlanta, Ga.	0.36-0.44	less than 1.5	1.0	100	0.20	0.2
Birmingham, Ala.	0.35-0.40	1.50	.....	.....	.....	.....
Buffalo, N. Y.	0.38-0.45	.....	.....	.....	.....	.....
Chicago, Ill.*	0.45-0.60	1.3-1.65	.....	.....	.....	.....
Cincinnati, O.	0.34-0.38	less than 1.70	.....	.....	.....	.....
Cleveland, O.	0.35-0.42	less than 1.70	.....	.....	0.20	1.0
Detroit, Mich.	0.40-0.45	less than 1.60	.....	.....	.....	.....
Grand Rapids, Mich.	0.35-0.44	less than 1.65	0.8	95	0.20	0.2
Hartford, Conn.	0.25-0.35	less than 3.0†	5.0	100	0.13	1.0
Kansas City, Mo.	0.40-0.50	less than 1.65	0.80	90	0.20	0.2
Indianapolis, Ind.	0.35-0.40	1.75-2.00	.....	.....	.....	.....
Louisville, Ky.	0.40-0.50	.....	.....	.....	.....	.....
Minneapolis, Minn.	0.40-0.50	approx. 1.55	.....	.....	.....	.....
New Haven, Conn.	0.25-0.35	less than 2.5	.....	.....	.....	.....
Oklahoma City, Okla.	0.35-0.42	less than 1.65	.....	.....	.....	.....
Philadelphia, Pa.	0.30-0.45	less than 1.75	.....	.....	.....	.....
Reading, Pa.‡	0.27	1.50	.....	.....	.....	.....
Richmond, Va.	0.38-0.45	less than 1.50	0.80	90	0.20	0.2
Sacramento, Calif.	0.33-0.42	less than 1.50	0.80	90	0.28	1
St. Louis, Mo.	0.40-0.50	less than 1.65	1.2	95	0.25	¼
St. Paul, Minn.	0.36	1.75	.....	.....	.....	.....

*Specification for experimental filter. †Special requirements for uniformity coefficient given for different effective sizes. ‡Actual values for sands now in use.

Table III

Sieve No.	14	18	20	30	40	50	60	80	100
Clear opening	0.41	1.0	0.84	0.59	0.42	0.30	0.25	0.18	0.15

Effective Size.—The "effective size" is that size than which 10 per cent of the weight of the sand is finer and 90 per cent is coarser. It is expressed in millimeters and may be found by making a sieve analysis of the sand and determining the theoretical size of screen through which 10 per cent of the sand will pass.

Table III shows the clear openings of certain standard sieve sizes of the American Society for Testing Materials:

Uniformity Coefficient.—The "uniformity coefficient" is the ratio of the size than which 60 per cent of the sand is finer to the "effective size." It will be seen that if all the grains are exactly of the same size, the "uniformity coefficient" will be 1. These factors can be most efficiently determined by plotting a sieve analysis curve.

Specifications for size and grading usually state that no grains shall be larger than some size, generally about 1 mm., and limit the percentage of material finer than a small size, generally less than 1/5 mm. Generally, no requirements as to shape of grain are given except that they should not be flat or elongated, since, so far as is known, rounded or angular grains are equally efficient. Sands having effective sizes ranging from 0.20 to 0.70 mm. are used, but the values most commonly specified range between 0.35 and 0.65 mm. Uniformity coefficients vary from about 1.25 to 2.50, with a maximum of 1.50 to 1.60 as the average requirement.

It is important that the sand grains in a filter bed shall not be disintegrated by the water with which they are constantly in contact. For this reason a good filter sand should be of high silica content. To insure durability of the sand grains, it is generally required that not more than 5 per cent shall go into solution in hydrochloric acid after 24 hours digestion or that the sand consist of at least 90 per cent silica. Most specifications also limit the amount of calcium and magnesium carbonate. The upper limit varies in the different specifications, but it is generally not more than 2 per cent. Some of the specifications place limits on iron, alumina, alkalies, loss of ignition, etc., but most of them do not include these detailed requirements.

Gravel Requirements.—Gravel is used in filters for water purification and also in the treatment of sewage. In water purification the purpose of the gravel is to serve as a base for the filter sand and to permit complete and rapid drainage of the filter. The size and grading, therefore, while important, can be varied over a considerable range. The gravel base is usually prepared in several different layers, each made up of one size of gravel, with the coarsest material on the bottom and the finest material in contact with the sand. Table II gives typical requirements as to grading of filter gravels used in water purifications by several different cities. The same precautions with respect to disintegration of the gravel particles by the water must be exercised as described under filter sands.

Table II—Grading Requirements for Gravel for Water Purification Filters

City	Bottom Layer Thickness of Layer, In.	Bottom Layer Size of Gravel, In.	Second Layer Thickness of Layer, In.	Second Layer Size of Gravel, In.	Third Layer Thickness of Layer, In.	Third Layer Size of Gravel, In.	Fourth Layer Thickness of Layer, In.	Fourth Layer Size of Gravel, In.	Top Layer Thickness of Layer, In.	Top Layer Size of Gravel, In.
Birmingham, Ala.	..	1 to 2	..	½ to ¾	..	¼*	..	.....	..	.....
Cleveland, O.	..	¾ to 1½	..	¼ to ¾	..	⅛ to ¼	..	1/16 to ⅛	..	.....
Grand Rapids, Mich.	8	2	3	1	2	½	2	¼	2	⅛
Hartford, Conn.	7	1 to 2	2½	⅜ to 1	2½	⅛ to ⅜*	..	.....	..	.....
Kansas City, Mo.	4	1½ to 2½	4	1 to 1½	4	½ to 1	3	¼ to ½	3	1/12 to ¼
Memphis, Tenn.	7	1 to 2½	4	⅝ to 1	2	⅝ to ⅝	2	3/16 to ⅜	3	No. 10 to 3/16 in.
Philadelphia, Pa.	6	1 to 2	3	½ to 1	3	¼ to ½	3	⅛ to ½	3	No. 12 to ⅛ in.
Richmond, Va.	7	1 to 2½	4	⅝ to 1	2	⅝ to ⅝	2	3/16 to ⅜	1	No. 10 to 3/16 in.
Washington, D. C.	5	1¾ to 2½	6	¾ to 1¾	6	¼ to ¾	2	⅛ to ¼	1	⅛ to ⅛

*Top layer.

Mixing and Coagulation in Water Works Practice

General Theory of Coagulation of Chemicals in Water Purification

By M. P. HATCHER

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ALTHOUGH recognized as an important operation in the water treatment plant, the mixing and coagulation of chemicals has been given surprisingly little consideration in water works literature. There may be an explanation of this condition. Changing conceptions and the lack of comprehensive data on the subject may have contributed to its general neglect. Several investigators have given us information on reaction time and water velocities necessary in a general way to satisfactory results and some information is available on specific methods of mixing and coagulating but it may be said in general that the subject deserves more consideration than it has heretofore been given.

Mixing and Coagulation Defined.—There is some confusion in the use of terms. "Mixing" should be understood to include only the action necessary to adequately mix the chemicals with the water. Since we are dealing with coagulation the chemical is generally termed the "coagulant." "Coagulation" is defined as the process whereby the flocculate precipitate is permitted to unite and coalesce into larger and more rapid settling particles. The "retention period" of a mixing or coagulating unit is the extent of the time required for the water to pass through the device as determined by its displacement. "Velocity" as discussed in connection with mixing and coagulation is understood to represent the average velocity of the water in the cross-section normal to the axis of flow.

The discussion of "mixing and coagulation" will in this paper be confined to that pertinent to the coagulation of chemicals for the purpose of assisting sedimentation and filtration, excluding references to the problems involved in the application of lime in softening plants. The mixing of lime and its attending reactions presents problems which are specific and beyond the scope of this discussion. This paper also assumes favorable chemical and physical conditions known to affect the perfect coagulation of chemicals in the water.

The Baffled Basin.—The baffled basin probably deserves first mention in any dissertation on mixing and coagulating devices. This method has been in continued use since the scheme of coagulation was first conceived and still has many exponents among the designing engineers and plant operators.

There are two general types of baffled basins. The one more generally used is the under-and-over type which consists of a series of vertical passages constructed of wood or concrete in an outer structure usually built of concrete. The water passes from the inlet to the outlet through these compartments passing over and under successive partition walls. In the around-the-end type the axis of flow is horizontal. A smaller number of changes in direction are required in this type resulting in lower total head loss. Restricted passages required to maintain velocities are, however, more economically obtained in the under-and-over type of basin. The loss of head and velocity requirements generally fix very readily the type of baffled chamber to use in any particular plant.

Well defined ranges of velocity and retention period are necessary to the successful operation of this type of coagulating device. The proper velocities according to published data, vary from about .5 to 2.0 ft. per second with current engineering practice favoring velocities of about .7 to 1.0 ft. per second. Satisfactory operation of the baffled chamber requires that the velocities be self-cleaning thus avoiding the inconvenience of frequent removal from service. An alum floc will remain in suspension in a velocity of .6 ft. per second while a velocity of 1.0 to 2.0 ft. per second is required to suspend some of the clay silts and fine sand. It has been found that the coagulation process is simplified in plants along the Missouri River, if grit chambers are provided ahead of the mixing and coagulating basins. The removal of the heavier materials effects a two-fold improvement in the coagulation process. The possibility of deposit at nominal velocities is reduced and a source of interference with reactions is removed.

Langelier in his Sacramento experiments in 1921 reported a more rapid flocculation with velocities up to 1.5 ft. per second and a satisfactory flocculation with velocities up to 2.0 ft. per second. The writer, however, shares the opinion more generally held that such velocities may tend to decrease the size of flocculated particles; the advantage at least does not seem to offset the difficulties and costs attending higher velocities.

Retention period requirements in baffled basins vary from approximately 15 to 30 minutes. Higher temperatures are favorable to the shorter periods where longer periods are provided for the lower temperatures. Operators have found it advantageous to apply the chemicals at some intermediate point in the mixing and coagulating basin, eliminating thereby some of the possibility of destruction of the floc after it has reached its best condition.

The requirements of velocity and retention period impose their limitations on the use of the baffled basin as a mixing and coagulating device. Plant operating capacities may have a 100 per cent seasonal variation. If reasonably high minimum velocities are chosen for low operating rates, the velocities at maximum rates result in high head losses, in the baffled basin, making design both awkward and expensive. Head losses of 4 and 5 ft. are not unusual in this type of design. Head loss variation may be reduced if the mixing chamber is divided into two or more units using the number of units which will provide desirable velocities.

Baffled basins lack also the flexibility that is desired. Velocities in the compartments are fixed by plant operating rates. Variations in the character of the raw water may make desirable a change in velocity. This velocity can be obtained only by the use of the unit plan mentioned which tends to increase costs of structures. These shortcoming have led in many cases to the choice of other methods of mixing.

Mechanically Agitated Plant.—Coagulation is accomplished in a large number of water treating plants by mixing the applied chemicals with the raw water in tanks agitated by mechanically operated paddles. Flexibility in mixing velocity may be obtained by the provision for varying speeds in the stirring mechanism. Retention periods may be varied by the series or parallel operation of several tanks. The head loss through these units is of course small.

Velocities and retention periods in the mechanically agitated tank are made to conform to the requirements mentioned for the baffled chamber, the nominal velocity being assumed as that at the two-thirds radius point. Published data indicate that efficient mixing is obtained when the paddle area is 25 per cent of vertical cross sectional area of the tank. The writer knows of instances where satisfactory results are obtained with a single propeller type of paddles at the bottom of the tank. Several different arrangements of inlet and outlet have been used with success but theoretical considerations indicate that center inlet with circumferential take-off is preferable.

The Hydraulic Jump.—The hydraulic

jump has been studied with reference to its adaptability to the function of mixing by J. W. Ellms. The hydraulic jump may be described as the manner in which water is conveyed in restricted channels to a lower level with a consequent dissipation of energy through internal impact. The turbulence of the water at the jump brings about a condition which is ideal for the mixing of the small volume of chemical solution with the much longer volume of water. While the retention period is estimated to be only about 30 seconds the chemical reaction has been shown by experiments to be quite complete. The loss of head through the jump is less than that ordinarily required in the baffled basin, maximum efficiencies being claimed for head losses of .75 to 1.0 ft. This device is in use in a number of plants.

Spiral Inward Flow Method.—Mixing of chemicals and water is accomplished in a few plants by a method generally described as the spiral inward flow. Water is applied tangentially in a circular tank and is removed through a tap or bottom outlet pipe at the center. The arrangement of inlet and outlet causes the water to follow a spiral path from the periphery of the tank to the center. The displacement volume of the tanks provides in cases where this device has been used, a retention period of about 30 minutes. The water in following the spiral path from the periphery to the center moves with increasing velocity to the outlet. Considerable turbulence is produced by the swirling motion at the center just as the water is leaving the tank. Head loss requirements in this type of mixing device vary with the velocities obtained, allowances generally made ranging from 1 to 4 ft.

The types of mixing and coagulating devices in most general use have been enumerated and described. There are other devices, however, that should be mentioned briefly. The centrifugal pump, though not readily recognized as a mixing device, is sometimes used as such. Chemicals are applied in the suction and are mixed by the turbulent agitation produced in the pump. Mixing in some plants is accomplished by application of chemicals to the inlet lines to the settling basins. The Chain-of-Rocks filtration plant at St. Louis uses as a mixing device a series of underground concrete conduits wherein suitable velocities and retention are obtained. One manufacturer offers a mixing device which employs mechanical agitation with modifications of the usual methods. Another suggests the use of a device used in sewage disposal as an aerator. Practice indicates that some degree of coagulation can be obtained by a large variety of methods.

In order that we may more satisfactorily solve the problems of mixing and coagulation it is desirable that we analyze the processes involved with a view to determining the conditions most suitable to their accomplishment. The results of experimentation and practical operation now available should enable us to draw some general conclusions.

The original investigations of the hydraulic jump as a mixing device made by Mr. Ellms in about 1920 in connection with the report on water treatment at Milwaukee were reported without reference to the use of any adjunctive provision for coagulation. Nor was this need suggested in the earlier recommendations for its use. Excellent agitation was produced by the action of the hydraulic jump and it seemed reasonable to assume that a rapid and thorough distribution of the chemicals in the water might improve the process of coagulation. It is quite significant that the chemical reaction is completed in the hydraulic jump in the short time of 30 seconds. The contrast with the 30-minute period of the baffled basin pointed to distinct advantages for the hydraulic jump.

Later developments suggest a more complete analysis of the phenomena of mixing and coagulation. The experience of the writer has indicated that perfect coagulation requires something more than a completed chemical reaction. Mr. Ellms states in his later deductions that "gentle agitation produced by a velocity of flow from .75 to 1.0 foot per second hastens floc formation and produces a good aggregation of finely divided particles in 5 or 6 minutes."

Complete Coagulation Two Separate Steps.—The writer submits that complete coagulation should be considered as a process of two separate and distinct steps: (1) The chemical reaction of the coagulant and the treated water, (2) the physical change involving the aggregation of the flocculent precipitate and that overlapping of these two steps will not permit the best results. The first step is accomplished by any method which will bring the coagulant in close contact with all the water. This requirement points readily to violent agitation. The second step is accomplished best in velocities which will barely keep the floc in suspension. It is evident that violent agitation would be detrimental to the aggregation of floc and it is apparent that the chemical reaction would not be accelerated by the slow velocities favorable to the formation of the floc. It appears that only 5 or 6 minutes of gentle agitation are required to produce perfect coagulation after the chemical reaction has been completed. Since 15 to 30 minutes are required for complete coagulation in the baffled basin or mechanically agitated tank, we may reason that the first 10 to 25 minutes in these devices are consumed in bringing about the first step or chemical reaction which is completed by violent agitation in 30 seconds.

It is interesting to consider the methods employed in the devices described in relation to the method prescribed in a manner by the analysis of the general theory of coagulation as presented. If the chemical reaction can be completed in 30 seconds of violent agitation then excess capacities are being provided in baffled basins and mechanically agitated tanks where the same function is accomplished in a much longer time. The hydraulic jump appears to perform only the first step in the process. If the mixing process is followed immediately by the settling basins, the slow velocities therein will permit some of the floc to settle out before its full usefulness is developed. It seems desirable that a short period of gentle agitation follow this device. The spiral inward flow basin with a much larger capacity performs a service equivalent to that of the hydraulic jump but is not as efficient in the writer's opinion with equal energy losses. The action in this type of mixing device is, in fact, just the reverse of that desired for mixing and coagulation. The turbulent agitation is produced at the outlet where gentle agitation is required to preserve the floc. Low velocities prevail at the inlet where turbulence is desired.

Lack of uniformity in the fundamental principles of the mixing and coagulating devices in use indicate the necessity of further experimental study of these principles. The general theory of mixing and coagulation as outlined in this paper has served the writer as a means of comparing and studying the methods advanced from time to time.

Acknowledgment.—The above paper was presented at the 11th Texas Water Works Short School.

National Water Works Corporation Purchases $4,000,000 of Properties.—The National Water Works Corporation has acquired new properties valued at more than $4,000,000 in West Virginia, New Jersey and Pennsylvania. One company purchased was acquired from the United States Steel Corporation. This is the Mount Pleasant Water Co., organized in 1881, serving Mount Pleasant, Pa. Other Pennsylvania properties acquired are the Citizens Water Co. of Scottdale and the Gettysburg Gas Co. The West Virginia companies include the Buckhannon Water Co., Kingwood Water Co. and the Philippi Water Co., serving towns of the same name. In New Jersey, the Riverton & Palmyra Water Co. has been acquired.

Water Supplies in Michigan.—There are 331 public water supplies in Michigan, of which 112 are surface supplies. Fifty-two of these supplies are protected by chlorination only and an additional 27 are filtered. An additional 21 supplies are not supposed to be used for domestic purposes, being essentially fire protection supplies, mostly in small places.

Preammoniation at the Water Purification Plant of Springfield, Illinois

Experiences in Use of Ammonia As a Preventive of Chloro-Tastes

By CHARLES H. SPAULDING
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SINCE February, 1928, the Springfield water purification plant has used ammonia as a preventive of chloro-tastes with very satisfactory results. Prior to that time we were sometimes troubled with slight tastes associated with chlorination. While these were usually not sufficient to cause serious complaint, they did occasion remarks from time to time and left an opening for unfavorable criticism. Soon after beginning the ammonia treatment, we received a number of voluntary compliments on the improved taste of the water and occasionally find the impression that no chlorine is used at the Springfield plant.

The use of ammonia as an aid in disinfection is mentioned in standard texts. As a taste preventive, however, McAmis, at Greeneville, Tenn., seems to have been the first to use ammonia.

Preliminary Experiments at Springfield.—The bacterial loads in the raw water at Springfield have been excessively heavy. It was important in our case, therefore, that nothing should be done to lower the efficiency of chlorination, but that everything possible should be done to increase it. Some laboratory tests were then made to determine how disinfection would be effected. I used a pure culture of B. Coli added to samples of boiled distilled water and also to raw river water. In each case the disinfection accomplished in one hour was greater when ammonia was added to the water just before chlorination. The results on distilled water and raw water are shown in Table I.

These results were very encouraging, for preammoniation would thus rank as an additional measure of purification as effective in removing bacteria as other stages such as coagulation or filtration. However, we were disappointed in our next experiments in which lime was used as well as chlorine and ammonia.

Table I—Effect of Preammoniation on Disinfection with Chlorine

	Pounds per Million Gallons Ammonia	Chlorine	B. Coli per Cubic Centimeter	Per Cent Remaining After 1 Hour	Residual Chlorine
			Boiled Distilled Water		p.p.m.
A	0	0	29,500	100	
	0	1.0	535	1.8	
	0.5	1.0	20	0.07	
B	0	0	15,000	100	0
	0	1.0	50	0.3	0.10
	0.5	1.0	5	0.03	0.10
			River Water		
	0	0	39,000	100	0
	0	4	13,600	35	0.06
	2	4	650	1.7	0.06

Table II—Effect of Preammoniation on Chlorination of Lime Treated Water

Pounds per Million Gallons Lime	Ammonia	Chlorine	Total Count per Cubic Centimeter	Per Cent Remaining	Residual Chlorine p.p.m.	Alkalinity Phthalein	Total
0	0	0	25,500	100	0.0		194
1,200	0	0	24,500	96	0.0		
1,200	0	5	875	3.4	0.20	50	76
1,200	1	5	875	3.4	0.20	50	74
1,200	2	5	2,400	9.4	0.23	50	76
1,200	3	5	2,450	9.6	0.26	55	80
1,200	4	5	3,250	12.7	0.30	43	74

In this case the results after one hour of contact were less satisfactory with ammonia than without. The data on one group of tests with lime, ammonia and chlorine are shown in Table II.

The water used in this case was river water having a total count of 4,300 per cubic centimeter, to which a broth culture of B. Coli was added sufficient to give the initial count of 25,500 per cubic centimeter. Thus the organisms added greatly predominate, although they are not in pure culture. Lime, ammonia and chlorine were added in the order named while the samples were being stirred in a stirring machine for 5 minutes. They were then allowed to stand 55 minutes, after which stirring was resumed for 5 minutes and the samples taken up into the pipettes while being agitated. Alkalinities and residual chlorine were determined after plating out the bacterial samples.

The fact that a moderate causticity has little effect on B. Coli reduction in 1 hour is illustrated by this set of samples which was treated and titrated at room temperature. We have since found that no conclusions as to lime sterilization are valid unless temperature is stated, but in this case all samples were from the same batch and of the same size, and run at the same time, so that any temperature changes were of the same magnitude. Therefore, the comparison is accurate enough for the present purpose.

This experiment was twice repeated and samples taken at intervals up to 6 hours. The results confirmed the previous tests in general, but the indications were that still further reductions would be obtained with longer contact, and a fourth set was carried through to 21 hours and sampled five times during the run. The results in this set are shown in Table III.

As before, diluted broth culture of B. Coli was added to raw river water. The total count of the raw water before addition of the broth culture was 3,700 per cubic centimeter, and after the addition, 32,000. The results cannot be said to represent B. Coli efficiencies strictly for that reason. However, these comparisons have been made at times when the initial count of the raw water was only 0.5 per cent of the B. Coli added. The trend is always the same. Chlorine works best at lower pH values, that is, without lime. The addition of lime slows the chlorine sterilization, and the further addition of ammonia retards it still more. Yet in eight hours the four chlorinated samples have reached nearly the same point. Lime by itself is very slow in comparison. In this case the alkalinity was determined only at the end of 21 hours, and the water was exposed to recarbonation throughout the run. The alkalinity at the end indicates from 5 to 25 p. p. m. causticity and values of pH above 10 at least at the beginning of the run.

From these experiments it is evident that the best time to apply chlorine is prior to the addition of lime. It is plain that, if ammonia is used, a very marked increase in efficiency will result, providing the sterilization is complete before the addition of lime. It was not practical to realize these advantages without considerable additional capital investment at Springfield, and they were not attempted. The next best procedure is prechlorination to allow the maximum period of contact. Ammonia can be used in small amounts provided the contact period is sufficient. If the ammonia permits higher chlorine residuals without taste, then the retarding effect may be more than balanced by the free use of the sterilizing agent.

At Springfield, the nominal detention periods in the various stages of purification are as follows:

Mixing chambers		40 minutes
Clarifiers	1 hour	40 minutes
Settling basins	4 hours	
Carbonating chambers		30 minutes
Filters		30 minutes
Clear well (full)	4 hours	
Nominal total	11 hours	20 minutes

The actual flowing through time may be much less for a part of the water or for all of the water under certain circumstances such as low clear well or

Table III—Relation of Contact Period to Bacterial Reductions in the Lime-Ammonia-Chlorine Treatment
(Temperature Constant at 17.5°C.)

Pounds per Million Gallons			Per Cent Remaining						
			Hours Contact					Residual Chlorine	Alkalinity
Lime	Ammonia	Chlorine	1	2	4	8	21		Phthalein / Total
0	0	0	100	103	91	88	106	0.0	197
1,200	0	0	69	75	66	59	17	0.0	35 / 65
0	0	4	22	1.1	0.9	0.6	0.5	0.02	197
1,200	0	4	44	16	2.7	0.7	0.5	0.09	30 / 60
1,200	1.0	4	31	33	6.6	0.7	0.5	0.11	32 / 62
1,200	2.0	4	56	35	17.0	0.9	0.5	0.12	31 / 64

basins out of service. However, the plant is being operated at about 60 per cent of its capacity, so that the above figures should not be far from the facts on the average.

Four Classes of Tastes.—It was hard to establish definitely the sources of taste at Springfield for the tastes were not distinct as a rule. They were seldom sufficient to permit agreement by any two observers as to their quality, and for the most part passed unnoticed. Yet I believe we can now distinguish four classes. First, there was, occasionally, a medicinal taste at remote points on the distribution system sufficient to make the water unpalatable and to give credence to those who somewhat vaguely described a taste at other times. Second, a moldy chlorinous taste appeared occasionally after showers, usually associated with higher turbidity and higher chlorine dosage though not necessarily higher chlorine residual. A third class of tastes is associated with sudden thawing of ice over a large area of watershed following a sleet storm or frozen flood conditions. This is naturally rare, but may be extremely disagreeable. The fourth class of tastes is derived from algae and is not affected by ammonia treatment so far as we now know. With the possible exception of the first class, all of these are more correctly described as odors.

Under the circumstances it seemed as well to try the ammonia first on a plant scale, since it is simply applied, cheap and harmless, whether effective or not. The results were noticeable at once. The dose of ammonia was set at 5 lb. per day treating 7 million gallons of water. The quantity has been sufficient with the exception of a few brief periods when double the amount was used. During these periods it was possible to get a better idea of the effectiveness of the ammonia treatment through laboratory experiments which were made accordingly. For example, one set of bottle experiments is shown in Table IV.

Table IV—Experimental Treatment—Taste Prevention
(Temperature Maintained at 6°C.)

Sample Number	Chlorine, pounds	Ammonia, pounds	Taste After 40 Minutes	Odor After 40 Minutes	Residual Chlorine p. p. m.
1	6	0	2	1	0.20
2	6	1	1	0	0.23
3	6	2	0	0	0.26
4	8	0	3	3	0.30
5	8	2	1	0	0.35
6	8	3	0	0	0.40

Note: 1,200 lb. of lime and 200 lb. of alum were used in each case.

Samples were treated with chemicals as in the plant, except that chlorine and ammonia were varied. It is not possible to give a numerical value to taste with our present knowledge, and the figures in the taste and odor columns simply give the writer's opinion of the relative magnitudes. But where zero is recorded, all of several observers agreed taste was absent, while the value 3 indicates the consensus of opinion as to the worst of the group. Moldy and chlorinous would best describe the quality. The plant treatment on this day was 9.2 pounds chlorine and 1.6 pounds ammonia per million gallons, and no taste was present in the plant effluent. The experiment demonstrates that this class of tastes and odors is prevented at Springfield by the use of ammonia. Similar experience has been described recently by Harrison at Bay City.

The taste described as medicinal develops more slowly and is difficult to catch at the plant. A 24 hour composite sample of raw water, however, was examined by Mr. Theriault, chemist, United States Public Health Service, who reported a recovery of 1.2 parts per billion of phenol, and the fact that this amount is sufficient to cause a chlorophenol taste. Subsequently I have treated boiled distilled water with phenol in amounts from 2 to 50 parts per billion and have found that ammonia effectively prevents chlorophenol taste when used in the ratio of ½ lb. ammonia to 1 lb. chlorine. This conclusion is at variance with that of Harrison, whose results with ammonia in chlorophenol taste prevention were negative. There are several points of difference, however, in the way the experiments were made which may explain the discrepancy. He has used larger amounts of phenol and does not state what sort of water was used in the test. If it was not phenol-free, the difference in quantities might be still greater. Furthermore, in our case, lime water was added to the distilled water sufficient to produce a pH value of 9.6, which would approximate our plant effluent. Since pH makes a considerable difference in the activity of the chlorine, it may also affect the taste production. This point would stand further investigation. In our case cited the chloro-phenol taste developed somewhat from the start, but after 24 hours in the refrigerator it was very decided and roughly proportional to the phenol added. The samples pretreated with ammonia were entirely free from taste. These experiments and the plant experience indicate that, in a softening plant at least, ammonia may and in our case does prevent chloro-phenol taste.

No laboratory experiments have been made on the thawing ice complex which has occurred only once at this plant. As soon as discovered, the ammonia was increased from 0.7 to 1.7 lb. per million gallons in the raw water, after which the odor disappeared. The chlorine dose at this time was 7 lb. per million gallons. The following day complaints were received of the odor from hot water faucets. We are not sure whether this could have been entirely prevented by an earlier increase in ammonia dosage. There was no suggestion of chlorine in the odor. Using the hot test, both raw and filtered water will usually have some odor, more intense in the raw than in the filtered. For these reasons no definite conclusions could be drawn, but we were certain that the odor and taste of the cold water were immediately improved by increased ammonia.

Effect on Plant Operation.—It was shown by the preliminary experiments that no increased efficiency could be expected directly from preammoniation at this plant, but if chlorine could be used more freely, then indirect benefits might accrue. Table V includes the pertinent data summarizing the effect on plant operation.

It will be seen that chlorine consumption has increased, due to chlorinating raw water and due to the higher residual. On the other hand, less coagulant was used during the past year than previously. The net result is a saving of 41 ct. per million gallons treated, or 29 ct. if the cost of ammonia is included. The time required for disinfection is sharply brought out in the comparison of bacterial results at various stages in the process. For example, the clarifier effluent in the past year showed 33 per cent of the B. Coli index of the previous year. The water applied to the filters contained 16 per cent of the previous index, while the filtered water contained only 5.5 per cent of the former figure. The improvement practically stops at this point since the final chlorination now merely fills any sags in the chlorine residual.

Secondary Contamination.—In the tabulation for 1928-1929, the B. Coli

Table V—Comparison of Plant Records
Fiscal Year, March-February

	1927-1928	1928-1929
Number months prechlorination used	1	12
Total chlorine used, pounds per m. g.	2.9	6.1
Residual chlorine final, p. p. m.	0.12	0.18
Ammonia, pounds per m. g.	0.06	0.72
Coagulant, pounds per m. g.	185	82
Turbidity, p. p. m.:		
Raw	111	99
Applied	7.6	7.2
Filtered	0.04	0.01
B. coli per 100 cc.:		
Raw	19,757	21,122
Clarified	187	62
Applied to filters	134	22
Filtered	12.3	0.68
Chlorinated	0.36	0.25
City tap	0.12	0.11

index of the final effluent has had to be corrected and a considerable number of positives thrown out for the following reasons. The sudden appearance of B. Aerogenes in the discharge of a high service pump led to the discovery that the packing of this pump was contributing quantities of bacteria which in the ordinary routine would be classed as B. Coli. These bacteria, grown on Levine's eosin methylene blue agar, gave large convex confluent colonies usually with metallic sheen, when present, limited to small central area, the colonies appearing brown by transmitted light. The bacteria were nonsporing rods. Without carrying the identification further, I felt justified in classifying these as B. Aerogenes. From a sample of the packing taken from the pump, I estimated twenty billion B. Aerogenes per pound. New packing was then examined and found to contain the same organisms in great abundance. Eventually a packing was secured free from these bacteria, but meanwhile much water had gone through the pump. However, due to the chlorine residual maintained with the aid of preammoniation, the water from city taps showed very few of these bacteria. For example, one monthly record shows the following:

B. Coli Indices, August, 1928

Pump suction	0.15
Discharge	1.4
City tap	0.13

While these particular bacteria had no sanitary significance in our opinion, the case is cited as an illustration of the disinfecting effect of the residual chlorine which averaged 0.23 p. p. m. during the month. The effect is particularly valuable at this plant, located as it is on the bank of a river in which the B. Coli index is frequently over 100,000 per 100 cc. The clear well and flow lines extend below low water stage and much of the structure is surrounded with cinders or other loose material. Under flood conditions they are under as much as 18 ft. of pressure from without. A leak of 50 to 100 gal. per day would reduce a sterile water below standard unless it carried some protection.

Application of Chlorine and Ammonia.—The program which has finally been adopted with reference to chlorine and ammonia is as follows: Ammonia is added at the rate of 0.7 lb. per million gallons at the inlet of the raw water dosing well, where the detention is about 30 seconds. Chlorine is applied at the outlet of the dosing well in amount sufficient to produce a residual of 0.2 to 0.3 p. p. m. in the effluent of the clarifiers. As a rule, the residual drops slightly by the time the water has passed the filters, and additional chlorine is then added to bring the residual back between 0.2 and 0.3 p. p. m. If no drop has occurred, the second chlorination is omitted. As a rule, 1 lb. per million gallons is sufficient at this point.

The application of the ammonia has been made by solution prepared from anhydrous ammonia and delivered to the water from a small orifice below a tank holding 190 gal. of solution containing from 10 to 20 lb. of the gas. However, the present practice is to apply the gas directly through a needle valve and a bubble meter consisting of a bottle of light oil through which the gas rises. In this arrangement the rate is regulated by the number of bubbles per minute, 280 bubbles per minute being equivalent to 5 lb. per day. The rate of flow is extremely constant, the valve frequently requiring no adjustment over a 24 hour period. The capacity of the device as at present is about 10 lb. per day, which is the maximum and exceptional amount used. The ammonia tank stands on a scale, and the weight is recorded at regular intervals. The gas enters an alum solution line through which a small stream of water carries it into the dosing well. Whether or not the alum line is carrying coagulant is of no consequence.

Ammonia can be bought in many forms. Salts of ammonia could be applied from a dry feeder, but we have found the cost per pound of NH_3 is less for either aqua ammonia or anhydrous ammonia, which are very nearly the same delivered at Springfield, namely 15 ct. per pound.

In view of the advantages which we have found in preammoniation, either for taste prevention or for increased efficiency where lime is not used, this useful addition to water purification processes should find wider application. The method employed formerly was to prepare chloramine solution before addition to the water, and this troublesome procedure probably prevented more general use.

When Preammoniation Would Be Advantageous.—Bulletin No. 21 of Illinois State Water Survey contains analyses of municipal well supplies in Illinois. Taking the first hundred as typical, I find 23 per cent have less than 0.1 p. p. m. of NH_4. In chlorinating such waters, preammoniation will doubtless be found advantageous at times. On the other hand, the remaining 77 per cent contain up to 36.1 p. p. m. free ammonia as NH_4, with an average of 3.36 p. p. m., equivalent to 26.5 lb. ammonia per million gallons. Obviously it would serve no useful purpose to add ammonia to such water, although the knowledge of the ammonia content should throw considerable light on the behavior of chlorine in the water.

As compared with well waters, the rivers of Illinois are notably uniform in free ammonia content. Bulletin No. 5 (1907) of Illinois State Water Survey contains tabulations of sanitary analyses of municipal supplies, and I have arranged the ammonia data applying to surface waters in Table VI.

It will be seen that the average of each of the six stations is not far from the average of all, and the maxima and minima are not greatly divergent. A number of determinations which I have made on the Sangamon River at Springfield show but little variation from the value 0.090 p. p. m. N as free ammonia. Lake Michigan at Evanston, according to the above bulletin, contains slightly less than half as much free ammonia as the streams. We should expect, therefore, that, in general, the surface waters of the state will respond to preammoniation.

Conclusions. — Preammoniation increases the efficiency of chlorination of water having normal pH value and low ammonia content.

Preammoniation prevents chlorotastes, including chloro-phenol tastes in a lime softening plant.

With high pH values, considerable time of contact, as much as eight hours, should be provided if maximum sterilization is required.

Ammonia is simply and cheaply applied with no undesirable after-effects necessitating special vigilance.

Chlorine residuals sufficient to overcome subsequent contamination are feasible when ammonia is present.

Acknowledgment. — The foregoing was presented May 14 before the Illinois Section of the American Water Works Association.

Table VI—Nitrogen as Free Ammonia in Surface Waters of Illinois
Results in Parts per Million

	Average	Maximum	Minimum
Sangamon River at Decatur	0.094	0.272	0.008
Vermilion River at Danville	0.070	0.144	0.024
Kankakee River at Kankakee	0.087	0.184	0.016
Vermilion River at Streator	0.090	0.344	0.008
Mississippi River at Quincy	0.114	0.300	0.048
Mississippi River at Moline	0.071	0.176	0.040
Averages	0.088	0.237	0.024
Lake Michigan at Evanston	0.040	0.082	0.012

Water Works in Illinois.—There are public water systems in 507 municipalities of Illinois serving 4,956,698 people. Of these systems 441 are municipally owned and 66 are privately owned. The total number of supplies is 469, as in some cases two or more municipalities are served from one supply. A summary of supplies classified as to source is as follows:

Wells	369
Surface	79
Springs	9
Wells and surface	5
Wells and springs	2
Miscellaneous (mines and quarries)	5

Sludge Disposal at the Calumet Sewage Treatment Works

Experiences at the Imhoff Tank Plant of Sanitary District of Chicago

By A. H. GOODMAN and C. E. WHEELER

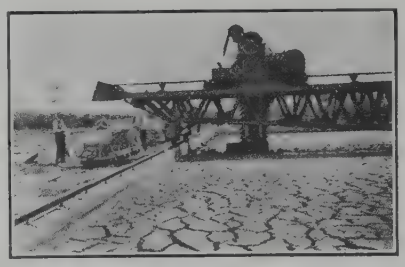
Respectively Plant Sanitary Engineer, and Assistant Plant Sanitary Engineer, Calumet Sewage Treatment Works, Sanitary District of Chicago

THE Calumet Sewage Treatment Works of the Sanitary District of Chicago, located at 125th St. just west of Cottage Grove Ave., is designed to treat the sewage of Chicago south of 87th St. and in addition, that of Blue Island, Riverdale, Dolton and several other small municipalities at some future period. The combined (domestic and storm water) sewage is brought by intercepting sewers to two pumping stations, one at 95th St. near the lake and the other at 125th St. and Michigan Ave. The flow from the latter station comes to the treatment works. The design capacity of the plant is 56 m. g. d. with an allowance for a 50 per cent increase for storm flow.

The sewage is measured by a Venturi meter and then passes through a rack screen with 1-in. openings equipped with a mechanical cleaner. It flows next through grit chambers which are equipped for cleaning with a grab bucket on an electric hoist working from a gantry crane. The velocity in the grit chamber is maintained between 0.75 and 1 ft. per second. The sewage then passes to 30 Imhoff tanks each 103 ft. 6 in. long by 34 ft. 6 in. wide, and 25 ft. deep. The sedimentation compartment is divided into 3 bays. There are 3 sludge hoppers in the shape of inverted frustrums of square pyramids. Gas vent area is 17 per cent of the total surface area.

Operation of Tanks.—Operation of the plant began on Sept. 12, 1922, when sixteen Imhoff tanks were put into service. The remainder of the Imhoff tanks were started on Dec. 16, 1922. The sewage treated is mainly domestic and somewhat weak in character. In 1924, however, paint waste began to cause trouble. Large quantities of oil are found at times. No foaming trouble has been noted from the sixteen tanks started in September but the tanks started in December went through a violent foaming period of about six weeks the summer of the next year, 1923. Since 1923 there has been no foaming in any of the tanks.

The tanks are arranged so that the direction of flow may be reversed. This is done regularly, the length of time in one direction rarely exceeding 2 months. This program appears to give satisfactory distribution of solids throughout the length of the tanks. Routine determinations of sludge levels are taken at 3-month periods in each hopper. These levels are taken with a common pitcher pump, equipped with a suction hose, which is lowered through the supernatant liquor underlying the scum in the gas vents until sludge is encountered. This method has proved to be the most dependable of any tried.



Sludge Removal Machine at Calumet Sewage Works

Disposal of Imhoff Sludge.—Sludge is removed from the sludge hoppers by an air lift. Water rings of perforated brass pipe are installed in each sludge hopper to stir up heavy sludge and to aid its movement, also to allow of some mixing of the digesting sludge mass. After being pumped from the hoppers the sludge runs by gravity to the original drying beds, which are adjacent to the tanks, or to two—150 gal. per minute Jennings pneumatic ejectors, which force the sludge to the additional beds installed in 1927. The total sand bed area at the present time is equal to 0.67 sq. ft. per capita on the designed population of 225,000 people or about 1.0 sq. ft. per capita on the present population. Sludge as wasted varies in moisture from a yearly minimum of 87.2 per cent water to a yearly maximum of 89.1 per cent. Average moisture of sludge over five years of operation has been 87.8 per cent.

Sludge is usually placed on the beds to an average depth of 9 to 11 in. At certain times of the year, in order to use the drying area to greater advantage, the depth is increased to 15 to 16 in. Filling 9 to 11 in. in average good drying weather permits the sludge to be removed from the beds in about two weeks, with a yearly average moisture content varying from 39.3 to 55.1 per cent. Sludge has been removed by hand with forks and carried away by a system of narrow gage railroad tracks and dump cars. The original sand beds are 66 ft. long and vary in width from 17 to 20 ft. The 24 in. gage industrial track is installed lengthwise in the center of each drying bed with a complete system of switches and main track for assembling trains outside. The new beds are 105 ft. long and 65 ft. wide with a similar track system going into the beds, 5 rows of track to each bed, making the distance between center line of tracks 22 ft. Motive equipment consists of three Plymouth industrial gasoline locomotives and forty ¾-yd. dump cars.

The sludge is removed from the beds by hand forking into the cars, the cars are assembled and hauled to a sludge pump for disposal at the north end of the property. This dump was built up on the clay spoil from the plant construction and is about 700 ft. long. The track is laid the long way of the dump. As the sludge accumulates it is pushed over the edge of the bank by a Parson's backfiller. This has facilitated greatly the handling of sludge at the spoil bank, and with the improved distribution the track must be moved not more than once per year.

Some figures on sludge quantities and analyses may be of interest.

Imhoff Sludge Removal Data

Year	Wet Sludge Pumped from Tanks Total Cu. Yd.	Moisture, %	Dry Sludge Removed from Beds Total Cu. Yd.	Moisture, %
1923	7557	87.2	3289	44.1
1924	13039	87.3	3938	41.2
1925	16073	89.1	7080	46.7
1926	18323	87.3	7524	51.3
1928*	13999	88.1	6014	55.1
1927	19864	87.5	7990	39.3
Total	88855	526.5	35835	277.7
Av.		87.8		46.3

*Plant shut down 4 months.

Total dry solids removed for six years—34,243,630 lb.

Dry sludge weight per cubic yard as removed 1,500 lb.

Sludge Analysis

Sample and Year	Moisture, %	Nitrogen, %	Volatile, %	Fixed %
Sludge from beds—'24	53.3	1.68	41.6	58.4
Sludge dump top—'23	43.3	1.33	32.8	67.2
Sludge dump intr.—'23		0.98	27.9	72.1
Sludge from beds—'27	52.45	2.00	40.2	59.8
Sludge dump top—'26	30.22	1.48	38.7	61.3
Sludge dump intr.—'26	46.86	0.99	42.6	57.4

Record of Temperatures, Imhoff Tanks.—The lowest average monthly temperature in the sludge compartment over the period of our record has been 40° F., which has also been the lowest temperature for the flowing-through compartment. The maximum for the sludge compartment occurred in September, 1926, and was 70° F., while the maximum for the incoming sewage on several occasions during August and September has been 69° F.

For the three years over which we have complete records the following condition prevailed.

No. of Months	1925	1926	1927
Below 50° F.	5	4	2
Above 50° F.	7	8	10
Above 60° F.	4	6	4

These figures indicate that in Chicago and vicinity for an average of 4 months per year temperatures in unheated digestion tanks will be so low as to retard digestion processes very noticeably.

Digestion of Settled and Activated Sludge.—Digestion of primary sludge and excess activated sludge has been studied on a large scale. These tests extended over a period of three years. An average of 1.75 m. g. d. of sewage was settled in an Imhoff tank and the effluent was treated by the activated sludge process. The waste activated sludge was returned to the incoming sewage of the Imhoff tank.

After six months of operation it was apparent that additional sludge digestion capacity was needed to provide storage for the bulkier sludge from the activated sludge process. An additional Imhoff tank was used to supply the extra capacity required. This was operated as a separate digestion tank. The partially digested sludge was pumped over into this second Imhoff tank where the digestion was allowed to continue until the sludge was in satisfactory condition for drying.

The activated sludge was wasted as slowly and as gradually as possible in order to obtain as nearly as possible continuous mixing of activated with fresh sewage solids in the Imhoff tank. Occasionally the flow of activated sludge had to be shut off so as not to withdraw too much from the activated sludge process. The combined sludge after digestion had all of the characteristics of Imhoff sludge produced at the plant except that it averaged about 2 per cent higher in moisture content as drawn, contained somewhat higher total nitrogen, and cracked into much smaller sections in drying.

Average figures for the entire period of experiment gave the following results: 9.4 cu. yd. per m. g. of activated sludge at 98.55 per cent moisture mixed with 2.2 cu. yd. per m. g. of fresh sewage solids at 90 per cent moisture (est.) gave 2.4 cu. yd. per m. g. of combined sludge at 89.8 per cent moisture. This amounts to an 80 per cent reduction in volume. The digestion of dry solids was based on determinations of suspended solids in the influent and effluent of the Imhoff tank and on the actual quantity of activated sludge wasted. These data over a long period indicated 32.5 per cent digestion of suspended solids.

This experiment at the Calumet Sewage Treatment Works indicated the practicability of satisfactory digestion of Imhoff and activated sludges. This procedure was adopted in the design of the West Side Treatment Works, where the waste activated sludge of the North Side Treatment Works will be mixed with the fresh incoming sewage of the West Side plant and the mixed settled solids digested.

Mechanical Removal of Sludge.—Mechanical sludge removal from drying beds became important to the Sanitary District with the development of the West Side project. Experimental work has been carried on at the Calumet plant for the last 3 years to help in the solution of this problem. Small-scale work was started with a roughly built cleaner which worked on a narrow gage platform car. This consisted of a set of fingers bolted to a sheet metal tray equipped with an angle-flight elevating mechanism for moving the sludge up the pan to the dumping position. The machine was pulled through the bed by a car-puller. The width of the strip taken was approximately 4 ft. This machine demonstrated the feasibility of the plan and the fact that sludge could be taken off a drying bed mechanically without removing excessive quantities of sand with the sludge.

The next development was a machine of quite similar principle with a span of approximately 16 ft. Different shapes of elevating angles were used.

In the fall of 1928 a practical working machine was constructed to operate over six of the new sludge drying beds (105 ft. x 65 ft.). This machine is a double truss structure spanning the width of the beds and supported by rails on side walls. The narrow gage track system was removed from the drying beds. The machine traverses the total length of the six beds. The equipment is completely motorized, receiving its power from a trolley system extending lengthwise of the beds.

The machine was developed by the Evers-Sauvage Engineering Co. It consists of a series of specially shaped buckets working on an endless vertical chain quite similar to a ditch digging machine. The buckets are equipped on their cutting side with sharpened teeth and cut a strip of sludge about 4 ft. wide across the narrow dimension of the beds. The carriage carrying the buckets moves into the sludge by a drive which is independent from that which runs the bucket elevator. The buckets dig into the sludge at a speed of 20 ft. per minute. The speed of the elevator is sufficient to raise the sludge as rapidly as it is forced into the buckets. The buckets dump into a short cross belt conveyor which in turn discharges onto a large belt which travels across the width of the bed and discharges into the narrow gage dump cars. These cars are pulled along by a gasoline locomotive as the sludge machine moves forward on the bed.

In some preliminary tests that have been made on the machine this summer the capacity on sludge of about 55 per cent moisture and from 5 to 6 in. deep appears to be about 1.25 cu. yd. per minute. The buckets can be elevated or lowered to strike the exact sand level. They appear to pick up an almost negligible quantity of sand. There are several ways in which the capacity of this machine may be increased.

Collection of Gas from Imhoff Tanks.—Closely connected with the problem of sludge disposal is the collection of gas from digesting sludge. One Imhoff tank was equipped with gas collectors in the gas vents, the total number of separate vents covered being 24. Half of these were equipped with collectors of the Imhoff type consisting of a submerged collector sloping upward from ends to center where a small opening is provided, covered with a screen of loosely laid tongue-and-groove material. This screen is to hold back scum and permit the passage of gas into the small collecting can. The Sanitary District type consists of a longitudinal sheet metal collector, which covers the whole gas vent area. There is a water seal around the edges and simple deflectors beneath, to direct the rising gas into the collector. On this type no screen of any sort is provided to check the rising of the scum.

The formation of scum under both types of collectors has been the principal operating difficulty in collecting the gas. The screens on the Imhoff type plugged very shortly after this tank was put into operation. They were then removed.

Gas production varies greatly in unheated tanks due to the wide variation in temperature. In this climate the month of maximum production is usually September and the minimum February. The quantity of gas produced in September may be from 5 to 10 times as great as the production in February. The average production for the year 1927 was 0.406 cu. ft. per capita per day and 5.15 cu. ft. gas per lb. of volatile matter. The analysis of the gas for a period of one year gives the following figures:

Carbon-Dioxide		Oxygen		Methane		Nitrogen		B.T.U./Cu. Ft.	
Max., %	Min., %	Max., %	Min., %	Max., %	Min., %	Max., %	Min., %	Max.	Min.
26.5	8.2	0.8	0.1	84.1	64.0	18.3	2.0	848.6	650.8
A typical complete analysis being:									
14.2		0.3		74.4		11.1		750.7	

Acknowledgment.—The foregoing is taken from a paper read June 21 at the second annual meeting of the Central States Sewage Works Association and presented in the July Sewage Works Journal.

Phenol Tastes and Odors in Water Supplies of Ohio River Cities

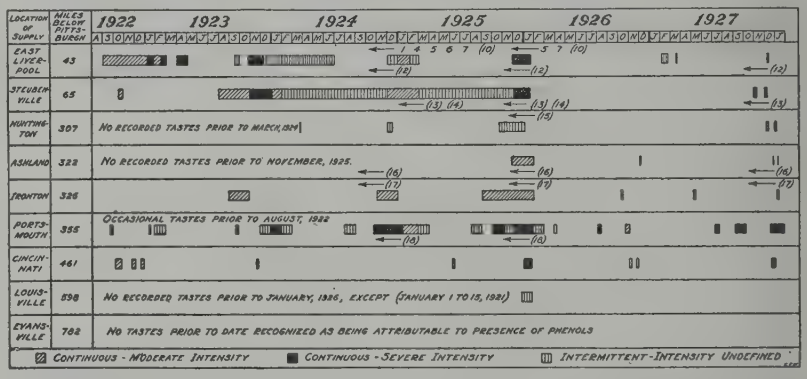
Reduction in Intensity May Be Due to Process of Natural Biochemical Oxidation

By H. W. STREETER
Sanitary Engineer, U. S. Public Health Service

FOR several years past, and particularly since the war, tastes and odors of such a nature as to identify them with the presence of phenols and allied substances have been experienced, with varying frequencies, in the water supplies of cities located on the inland waterway systems of the middle western and easter portions of the United States. Tastes of a similar nature have appeared in water supplies located in other areas, both of this country and of Europe. In no instance, however, has this difficulty been more serious or affected larger groups of population than it has in the area adjoining and tributary to the upper portion of the Ohio River, which drains a highly industrialized region serving as a center of the coal, steel, and allied industries.

Cause of the Taste and Odors.—A search for the specific causes of the tastes and odors above described revealed that fact that during and since the war period the coke-producing industry has been abandoning the use of the older "beehive" ovens for burning coke and has been substituting for them modern by-product plants, from which valuable substances are recovered from the gases which formerly went to waste in the atmosphere. The residues from some of these recovery processes, notably those concerned with the manufacture of benzol and ammonia, have been found to contain very considerable amounts of tar, phenols, cresols, creosotes, and similar substances, which, when discharged into sources of water supplies, produce characteristic "medicinal" tastes and odors in them.[1] Although other classes of wastes, notably those derived from producer-gas plants, have been found to contain phenols and similar taste-producing substances, the total amounts of phenols resulting from the operation of coke by-product plants are so much greater than those produced by any other single industry, and their production takes place in such highly concentrated areas, that a large share of the responsibility for the difficulties caused by wastes of this class logically has been attributed to them.

Aggravated Conditions Along the Ohio River.—In the upper portion of the Ohio River Basin, and especially along the Ohio River proper, the situation has been aggravated by the fact that, in order to produce bacterially safe effluents for drinking purposes, municipal water purification plants are forced to resort to continuous chlorination of the water in addition to coagulation, sedimentation, and filtration. This condition is due primarily to the large volumes of untreated sewage that is being discharged into this river system at the present time. The addition of chlorine to water containing small amounts of taste-producing phenols has been found to intensify the tastes caused by these substances, probably owing to the formation of chloro-phenol and allied compounds which are known to have exceptional taste-producing properties.



Key to locations of coke by-products plants:
1. Fairmont, W. Va. 2. Clairton, Pa. 3. Johnstown, Pa. 4. Warren, Ohio. 5, 6, 7. Youngstown, Ohio. 8. Farrell, Pa. 9 Pittsburgh, Pa. 10 Midland, Pa. (11) Woodlawn, Pa (12) Wierton, W. Va. (13) Follansbee, W. Va. (14) Benwood, W. Va. 15 Canton, Ohio. (16) Ashland, Ky. (17) Ironton, Ohio. (18) Portsmouth, Ohio. Numbers in parenthesis refer to plants located directly on the Ohio River; numbers not in parentheses refer to plants located on tributaries

Fig. 1—Graphical Record of the Appearance of Phenol Tastes in the Water Supplies of Designated Cities Located in the Ohio River, with Relative Location of Coke Byproducts Plants Discharging Phenol Waste Into the Ohio River

In March, 1924, a report was prepared by Sanitary Engineer H. R. Crohurst, of the Public Health Service, giving the results of a survey which he made of the water supplies affected by tastes of phenol origin and of the industrial plants producing phenol-bearing wastes within the Ohio River Basin. In his report, 17 coke by-product plants were listed at that time as discharging wastes of this character into the Ohio and it tributaries. Later reports submitted by the departments of health of Pennsylvania, Ohio, West Virginia, and Kentucky, at a joint conference held in February, 1926, indicated that about the same number of plants as that above named were actively discharging phenol wastes at that time in this river basin.

Records of Appearance of Phenol Tastes.—Systematic records of the appearance of phenol tastes in Ohio River water supplies have been maintained, since late in the year 1921, by operators of municipal water purification plants located along the river. These records have been collected by the United States Public Health Service from time to time and brought together for comparison. A comparative summary of these records, showing the period and, roughly, the relative intensities of phenol tastes observed in Ohio River water supplies, is shown graphically in Fig. 1, which has been plotted from the records thus collected. In this diagram are shown also the approximate locations, with respect to the various water intakes, of coke by-product plants discharging phenol wastes into the Ohio River and its tributaries at intervals during the period 1924 to 1927, inclusive. It will be noted in this connection that of the 17 plants indicated as discharging phenol wastes in 1924, only four were stated as remaining actual contributors in 1927.[2] The reduction was brought about as the result of joint efforts of the authorities of the Ohio River states and by manufacturers, following conferences held in 1924, 1925, and 1926. The work thus accomplished has been described so fully elsewhere[3] that it is

[1] These taste-producing substances will be designated hereafter by the single term, "phenols."

[2] In a recent paper by Waring (see reference in footnote 3), he indicates that, in the autumn of 1928, this number had been further reduced to two plants, located, respectively, at Wierton and Follansbee, W. Va.

[3] Waring, F. H.: Results Obtained in Phenolic Wastes Disposal under the Ohio River Stream Conservation Agreement. American Journal of Public Health, vol. 19, No. 7, July, 1929, pp. 758-770.

unnecessary here to discuss that phase of the subject.

On referring to Fig. 1, it will be noted that up to the end of the year 1925 tastes of phenolic orgin were present at frequent intervals and, during some periods, almost continuously, in the water supplies of East Liverpool and Steubenville, located, respectively, 43 and 65 miles downstream from Pittsburgh, and in those of Ironton and Portsmouth, located 326 and 355 miles downstream from the same point. At Ashland and Huntington, located short distances upstream from the Ironton-Portsmouth zone of the river, but about 240 miles downstream from Steubenville, the recorded tastes were considerably less both in frequency and intensity; likewise at Cincinnati, located about 106 miles downstream from Portsmouth. At Louisville, 130 miles downstream from Cincinnati, no tastes of phenolic origin were recorded until December, 1925, and January, 1926, when a wave of these tastes, of unusual intensity, extended down the river to this point.

change in the status of such tastes occurring after the winter of 1925-26 is further indicated by the following tabulation showing the months of the years 1924 and 1925, as compared with those of 1926 and 1927, in which tastes of phenolic origin were recorded in the water supplies of various Ohio River cities:

City	Total number of months in which tastes occurred 1924-25	1926-27
East Liverpool	11	4
Steubenville	24	3
Huntington	5	2
Ashland	3	3
Ironton	7	3
Portsmouth	13	8
Cincinnati	2	4
Total	65	27

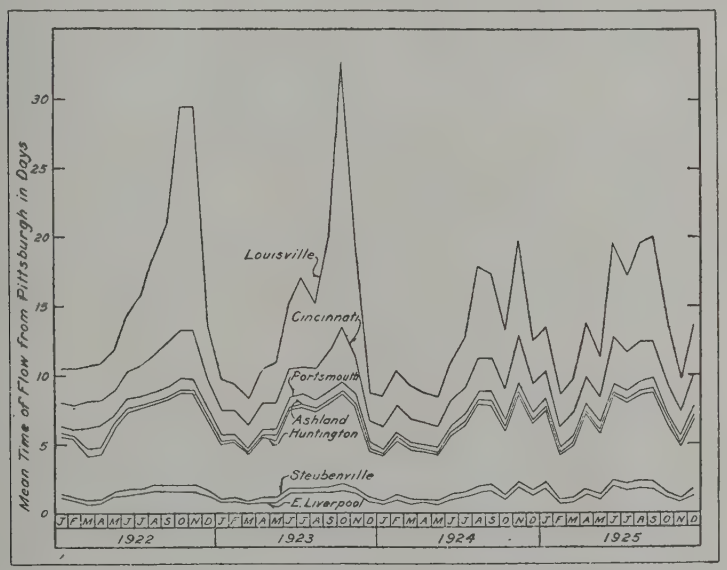


Fig. 2—Seasonal Variations in Times of Flow of the Ohio River from Pittsburgh to Designated Cities Downstream

Cooperative Control Efforts by States.—Following the December-January phenol wave of the winter of 1925-26, a renewed cooperative effort was made by the states of Pennsylvania, Ohio, West Virginia, and Kentucky to bring about the elimination of phenol-bearing wastes from the Ohio River system. The results of this effort, which left only four recognized sources of phenol pollution in the Ohio River at the end of the year 1927, were evidenced, as is shown in Fig. 1, by a well-marked diminution in the frequency and intensity of phenol tastes in Ohio River water supplies, the only outbreak of serious proportions during this period occurring in December-January of the winter of 1927-28. The figures given in the table fail to show the true contrast existing in the prevalence of tastes during the two periods indicated, because they do not take account of the greater intermittency and less intensity of such tastes during the later period. If these factors could be weighted properly, they probably would show that a reduction amounting to fully 90 or 95 per cent has taken place since the end of 1925.

Tendency to Natural Purification.—Aside from the foregoing indications, the conditions illustrated in Fig. 1 are of considerable scientific interest in that they afford fairly definite evidence that the concentration of taste-producing phenols in the river has had a marked tendency to become reduced progressively, in passing down stream, to a greater extent than can be accounted for by increased dilution or by any other wholly physical influence. The evidence at hand suggests very strongly, in fact, that a large part of the reduction observed is due to some natural process of purification, similar in its general mode of action to other phenomena commonly associated with the self-purification of streams.

The tendency above noted is indicated, broadly, (a) by the sharp reduction in the prevalence of phenol tastes observed in water supplies located at considerable distances down stream from sources of phenol pollution, as compared with their prevalence in supplies located in the more immediate vicinity of such sources of pollution, and (b) by the marked seasonal variations in the relative frequency and intensity of phenol tastes occurring in all of the Ohio River water supplies and especially in those further removed from sources of phenol pollution.

On referring to Fig. 1 it will be noted that during concurrent periods phenol tastes occurred less frequently at Huntington, Ashland, Cincinnati, and Louisville, all of which were located at distances of more than 100 miles downstream from recognized sources of phenol pollution, than at East Liverpool, Steubenville, Ironton, and Portsmouth, which were located within short distances of such sources of pollution. The reduction observed has been particularly striking between Steubenville and Huntington, a distance of 242 miles, and between Portsmouth and Cincinnati, a distance of 106 miles. In the latter instance the reduction in the frequency of phenol taste prevalence, amounting to over 80 per cent, occurred in a river stretch in which the total amount of dilution water added to the Ohio, mainly through the Scioto River at Portsmouth, ordinarily is less than 10 per cent. In the former case, it likewise could be shown that the reduction experienced in the prevalence of phenol tastes was far greater than would be accounted for in terms of added dilution water.

It further will be noted in Fig. 1 that although phenol taste-producing substances penetrated throughout the Ohio River as far as Cincinnati on several occasions during the winter and early spring, they did not appear during the summer or early autumn at any of the cities removed by any considerable river distance from points at which phenol wastes were discharged into the river. If dilution were a dominating factor in these variations, their trend would be expected to be exactly the opposite of that actually observed, since the maximum flow of the Ohio River occurs in the winter and early spring.

Although no data are at hand concerning the seasonal trend of production of phenolic wastes by coke by-product plants, it hardly would appear, from the nature of the industry, that such wastes could be produced in sufficiently greater volumes during the winter-spring season, as compared with the summer-autumn period, to account for the wide seasonal variations above noted.

The condition shown in Fig. 1 is entirely consistent, on the other hand, with the view that the seasonal and

geographic changes in phenol tastes prevalent observed in the various Ohio River water supplies have resulted largely from some natural process of purification which, though limited in its action, like all other processes of stream self-purification, is sufficiently powerful to bring about a marked progressive reduction in the density of phenols in stretches of the river relatively free from increments of pollution of this character. Thus, it is noted that the maximum reduction has occurred during the summer and early autumn seasons when the Ohio River usually reaches its lower stages, and the effect of longer times of flow, as illustrated in Fig. 2, is accentuated by that of higher stream temperatures. In general, the period in which evidences of phenol pollution, as gauged by the appearance of tastes in water supplies, have penetrated to the downstream points far removed from the sources of such pollution, have occurred coincidentally with shortened times of flow, as indicated in Fig. 2, and with relatively low stream temperatures, both of which conditions tend, in general, to bring about reduced natural purification effects in streams.[4]

Progressive Reduction May Be Due to Natural Biochemical Oxidation.—In the foregoing connection reference may be made to recent studies by Mohlman[5] and his associates, which have shown that the oxidation of phenols, which can be accomplished by ordinary biological processes of sewage treatment when phenolic wastes are mixed in proper proportions with sewage, is essentially a biochemical phenomenon, proceeding along definite time-function curves at rates varying closely with the temperature, being greater at higher temperatures, and vice versa. As the behavior of phenols in the Ohio River has been consistent, except in degree, with their reactions to artificial processes of oxidation, it would seem quite logical to infer that the progressive reductions thus observed under natural conditions may be due to a process of natural biochemical oxidation similar, in its general characteristics, to that which proceeds more intesively under artificial conditions.

If the foregoing theory is correct, its lesson is fairly obvious in so far as its application to problems involving the elimination of sources of phenol pollution of water supplies is concerned. In cases in which water supplies are subject to continuous or frequent pollution by phenols, the important sources of such pollution are more likely to be found in the near vicinity of the supply than at any considerable distance. If, however, they are subject only to occasional pollution, occurring more especially during the colder season or, in streams, coincidently with high river stages, the source of the trouble probably is located at a more distant point. In undertaking any general program of remedial measures looking to the relief of phenol pollution of water supplies, located along an entire stream, the maximum immediate benefit of such measures probably will be attained by eliminating, first, all sources of phenol pollution located directly on the stream in question or in the lower reaches of tributaries discharging into the main stream above the points at which the water supplies affected are located. The history of phenol tastes in Ohio River water supplies, both during and following the institution of progressive remedial measures by the bordering states, has afforded an interesting confirmation of the principle stated, as is indicated in Fig. 1.

The effectiveness with which the pollution of Ohio River water supplies by phenol wastes has been brought under a large measure of control within the comparatively short period of time intervening since the year 1925, constitutes one of the brightest pages in recent sanitary history. Accomplished, as it has been, without any coercive legislation, but through cooperative effort by the federal and state governments and the industries concerned, it augurs well for the future solution of some of the larger problems of stream pollution now confronting the nation. Although pollution of the Ohio River system by phenol wastes has not been completely eliminated, as evidenced by occasional "spills" which have occurred during the past year or two, it has been curbed to an extent such as to justify the expectation that in the near future it will cease to be a major problem along this important waterway. A generous measure of credit is due to those whose joint efforts have brought about this fortunate result.

Acknowledgment.—The above article is taken from the Sept. 6 issue of Public Health Reports. It is based on a discussion contributed to a symposium on phenol pollution, held at the annual meeting of the American Public Health Association, Chicago, Ill., October, 1928.

[4]See Public Health Bulletin No. 143, pp. 298-335; Public Health Bulletin No. 171, pp. 179-199; Public Health Reports, Reprint No. 1063, pp. 31 and 45; also Reprint No. 1232, pp. 9-13.

[5]Mohlman, F. W.: The Biochemical Oxidation of Phenolic Wastes. Am. Jour. of Pub. Health, Vol. 19, No. 2, February, 1929, pp. 145-154.

The Importance of Controlling the Raw Water

By A. L. GOSNELL
Filtration Plant Operator, Laurel, Md.

In presenting this article it is the writer's intention to bring out the importance of controlling the raw water where it is possible to do so.

The filtration plant at Laurel, Md., has a capacity of 500,000 gal. per day. The lake, or raw water reservoir, has a capacity of 7,000,000 gal. and is situated about a mile and a half from the plant. The stream entering the lake is derived from springs, and has a flow of about 500,000 gal. per day. This water, under favorable conditions, is exceptionally easy to control, yet under unfavorable conditions control borders on impossibility. The detention period in the lake is 14 days. The lake was made more than thirty years ago and the weeds, grass and bushes have been permitted to run wild, with the result that a favorable medium for algae growths has been produced.

It is customary to use copper sulphate to control algae growths, but we have learned that when trouble exists, the proper thing to do is to find the cause and remove it. Of course the proper thing to do in this case would be to clean up the filth and remove the weeds and grass around the lake. Cleanliness is of much importance even in the raw water. However, when the necessary cleaning is not done, it is necessary for the operator to take other steps. Past records revealed that during the winter months the pH of the water is about 7.0 and that from June to December it is about 6.0. It was the opinion of the writer that if the pH of the raw water could be held near 7.0, the carbonic acid would be eliminated, thereby cutting off the food supply of the growths and retarding their development.

In June, 1928, conditions were bad. A turbidity of 80 required an alum dosage of 1 g.p.g. for treatment. In an attempt to improve conditions, the lake was treated with hydrated lime. One hundred pounds of lime was spread around the entire circumference of the lake, extending about 5 or 6 ft. out from the shore. One bag of lime was tied up in a canvas bag with a few holes punched in it and anchored in the stream about 100 ft. above the inlet to the lake. The bag of lime was renewed every month from June to December.

The effect of the lime was noticeable almost immediately. A concrete dam that had formerly been covered with a slippery scum became clean and safe to walk on within a few days, the dose of coagulant was cut in two and the water was very easy to control. The treatment had only one objectionable effect: the oxygen content was increased to such an extent that the filters became air-bound in a 2½ to 3-hour run. However, this slight objection was overbalanced many times by the improved condition of the water. About 12 months were required to come to a decision as to the effect of the lime treatment. From July 4 to July 22 of this year the average turbidity was 150, with a maximum of 300, and at no time during that period did the alum dosage exceed ¾ g.p.g. This is in strong contrast to the dosage of a year ago, when a turbidity of 80 required 1 g.p.g.

Unusual Features of Filter Plant Design

Special Arrangements for Proposed Plant of Niagara Falls, Ont.

By F. A. DALLYN
Consulting Engineer, Toronto, Ont.

AS a preamble to this paper, I must state that the plant to which my remarks relate has not as yet been built. The design has been complete for something more than a year, and tenders were invited for the building in the spring of this year; but owing to misunderstandings and political and other controversies, the work has not yet gotten under way.

The Supply.—At Niagara Falls we have a Great Lakes water, taken from one of the connecting rivers at a point of high velocity—a water subject to some pollution, never very intense, and subject to turbidities which might be common also to such plants as Cleveland, Erie and Buffalo.

Lake Erie is a relatively shallow lake and storms promote a continuing turbidity, which sometimes exists for a week at a stretch. Ordinarily the water is fairly clear, possessing sufficient alkalinity to react with the aluminum salts without occasioning any aftermath of red water difficulties. The velocity of the river suggests that some difficulty might be encountered from frazil ice.

Construction Features.—The site selected for the location of the plant was a point on Dufferin Island, where the ground elevation was some 14 ft. to 15 ft. below the mean water level of the forebay of the Ontario Power Co., and the elevation of the rock formation which forms the base of the reservoir was discovered some 14 ft. below ground elevation— i. e., about the ideal position for foundations.

The site itself is part of the Niagara Falls Park system, and is heavily covered with vegetation, but accessible by road and by electric railway. The size of the plant, approximately 5,500 cu. yd. of concrete, suggested that a central mixing plant would be an economical arrangement, and the elevation of the approach suggested that material brought in on the electric railway could be dropped into bins and mixers without secondary handling. By an understanding with the Victoria Parks Commission, it was agreed to limit the destruction of trees to an area 75 ft. around the limits of the proposed works, and the problem of the contractor was to utilize this ground to such advantage as to permit him to carry on the works expeditiously without any further destruction of vegetation.

The contractors bidding on the work saw no particular difficulty in the arrangement, except that if the electric railway was not utilized there might be some embarrassment experienced, owing to the park superintendent limiting loading capacity of trucks and vehicles for the purpose of preserving and maintaining, during the tourist season, the river boulevard property, which also serves as approach to the plant.

The site naturally suggested a gravity plant with the high-duty pumps arranged so as to draw directly from the level of the clear-water reservoirs.

Mixing Chemicals.—The use of the hydraulic pump was considered and approved for the purpose of mixing chemicals, water being admitted from the upper forebay to the rising well and controlled by a mechanism actuating through floats and controlling the hydraulic inlet valve. After passing over the hydraulic pump, the water passes through the usual type of sedimentation tank and flows directly on to the filters through ports controlled by sluice gates, the wash-water channel and troughs being utilized for both the admission of sedimented water and the withdrawal of wash water.

Pipe Gallery.—The first unusual feature is perhaps the pipe gallery, with its arrangement whereby a travelling crane can be installed, hung from the upper beams, for the purpose of erecting and handling the control parts and pipes. The use of victaulic couplings rather than the flanged connections was contemplated, and in my opinion, offers considerable advantage.

Sand Strainers for Underdrain Systems.—The second unusual feature is the sand strainers for the underdrain system. Instead of making use of any of a group of patented arrangements, either of sand valves or special grids, I have recommended the use of a cast iron cover over a concrete trough, with a simple design of manifold cast integrally with the cover. This in itself is not unknown, having been used at St. Catharines. The unusual feature is that instead of screwed or leaded joints I propose to use a tapered push joint for the radial 1½-in. or 2-in. pipes, and hold them in place with a concrete haunch along the base of the tank. The arrangement has several very important advantages. It is incapable of a leakage greater than that from any one of the openings, and it is incapable of breaking away from the main header, as has been the case in some of the screwed pipes or leaded joints. It also appears to be a most economical arrangement.

Chemical Storage.—The next feature of interest has to do with the storage of chemicals. The plant which I was designing was to be such that it could be operated by the existing personnel, with the occasional inclusion of ordinary labor for special purposes. For this reason, instead of using overhead storage and dry feed machines, as is most convenient and satisfactory in a lot of plants, I used a portion of the foundations for wet storage of a saturated solution and capable of receiving several cars of chemicals. The chemical is taken from the cars and discharged down a manhole to a lower bin, which is immersed in water. When the storage is first charged, a portion of the chute will be full of undissolved chemical and will remain so until the use of chemical will have dissolved out the portion supporting the overlying mass. It was my intention to pump the concentrated chemical to a solution feed machine actuating from a constant level, diluting the solution as the reactions intimated was advisable.

In addition to alum storage, I purposed having track-work suspended from the ceiling of the screen room, so that I could use drums of ferric chloride, either to supplement the alum or to displace it entirely during periods when the ferric chloride might be suggested as the more suitable chemical.

Arrangement of Screens.—In the screen room, while it is not an unusual feature, the arrangement is specially adapted to the removal of frazil ice, and the screens themselves are of the sloping rather than the vertical type, so that they can be elevated out of the water, should conditions be acute. After passing the screens, the water flows directly over the pump and through the settling tank, and then on to the filters. Instead of using earth on top of the settling tanks, I thought it advisable to insulate them with cork, or other suitable material. According to the estimates, the difference in cost was not prohibitive, and it had a great many advantages which determined our policy in the matter. The entire roof of the building is also insulated, to keep down condensation and to simplify heating problems.

In the pumping station we have venturi controls both on the inlet water and on the water going to the suction well for the pumps. These controls are primarily for the proper application of chemicals. They also actuate the mechanisms which regulate the opening of the hydraulic valves, maintaining constant differential levels.

Piping Layout in the Pumping Station.—The piping layout in the pumping station is somwhat unusual in that provision is made for testing any of the several units in use, without throwing the station or other units out of service. The units have both duplicate discharge and duplicate suction lines, as recommended and urged by the underwriters. A by-pass has been introduced, so as to relieve the discharge system into the suction well for testing purposes.

The arrangement for the supplying of power for the operation of the electrical pumps is rather unique, although not novel to this plant, in that it provides an inter-switching arrangement with four of the principal developing companies at Niagara Falls, and precludes the possibility of any shutdown of duration.

It was my intention, in connection with the service pumps, to have push-

button control on the electric circuits and a hydraulic or electric valve operating the discharge line; the whole arrangement both of the filter plant and of the pumping station being such that the operators had a minimum amount of manual labor, and such appliances accessible as would permit the keeping of the staff down to the irreducible minimum.

Acknowledgment.—The above is an abstract of a paper presented at the Toronto convention of the American Water Works Association.

Financial Aspects of Municipal Water Works

Some Details That Make for Successful Operation

By C. A. McCLAIN
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AN essential foundation for the successful operation of a municipally owned utility is the proper attitude on the part of the citizens. They must be willing to adopt a charter so drawn as to admit of business-like conduct of the utilities without undue obstruction or hampering through formality and red-tape.

The Management.—The management should be in the hands of a commission stable in its organization, nonpartisan, independent in its action and separate from other departments of the city, whose members have no other city offices. They will thereby be free to make decisions and formulate policies for the best interests of the utilities and will be nonpartisan and uninfluenced by other city interests.

The management of the utility should be put on a sound and dignified business basis which will not give the citizens the impression that the utility is a plaything which may be used to meet the passing whims of various groups or organizations. The term of office of the members should be long enough to enable them to become really familiar with the problems involved and terms should so terminate as to bring one or at most two members on the board at the same time.

The Employees.—The financial status of any business whether a utility or a commercial enterprise is determined very largely by the organization or staff of employees. The same principles apply to this kind of organization as are effective in any other kind of business. They must be loyal, industrious and efficient, and their salaries should be as much as the same people would be paid anywhere else for doing the same kind of work. A city employee should not be expected to work for less than he could get elsewhere, and it is demoralizing for him to be required to apologize for his salary.

The service furnished by a municipal utility may be up to the standard of a privately owned utility if the ordinary rules of conducting such businesses are observed and if efficiency, initiative, loyalty and other desirable characteristics of employees are recognized and rewarded.

The Rates.—Rates should be as equitable as possible and should provide for the payment to the utility by the governing board of adequate rates for all service furnished for public uses, such as street flushing, sewer flushing, fire protection, street lighting and other service furnished for the general public. They should be sufficient for all legitimate requirements such as operation, maintenance, interest on bonds, sinking fund for retirement of same, an emergency fund, taxes if paid by the utility, and should also provide a substantial surplus for minor extensions for plant.

Taxation.—Municipally owned utilities are exempt from taxation in most states, although in some states a bookkeeping entry is required to show the status of the utility as if taxes were paid. Some utilities make a voluntary payment to the governing body of the city, while on other occasions the governing body exacts the equivalent of taxes or in some cases much more through its demands for free service. Practically all economists hold that municipal utilities should pay taxes the same as are paid by privately owned utilities, although some propose that all utilities be exempt because of the fact that the consumer must in all cases pay the tax.

If taxation is applied equally to all municipally owned utilities there may be no objection to this, although the legal requirement that all cities provide a sinking fund for the retirement of bonds in addition to all other requirements of operation and maintenance impose an additional burden on the municipal utilities which privately owned utilities do not have to carry and it would seem fair that the municipal utilities may be entitled to tax exemption because of this sinking fund requirement.

Financing New Developments.—In the case of new developments the capital required must of necessity be borrowed. The usual way of acquiring that capital is through the issuance of bonds. If these are general obligation bonds they usually carry a lower interest rate than that earned by securities on privately owned utilities although the sinking fund requirement mentioned above may entirely offset this advantage. In some states utility bonds are issued, that is, bonds secured by the utility itself, in which case the interest rate is about as high as that paid by privately owned utilities, and may even exceed that rate.

Securities Owned by Local Citizens.—The customer ownership plan which is coming into general use with privately owned utilities, is excellent, and it would be a decided advantage if the municipally owned utilities might avail themselves of this plan in the distribution of bonds directly to its own citizens. If this were possible the municipal utility could well afford to pay a higher interest rate than when its securities are owned by people not directly interested in the service. A substantial emergency fund should be provided, the size depending on the general type of utility and also on the individual utility as to its own hazards. It is not practicable to issue bonds for the construction of every small extension required for service and therefore it seems a good policy to provide for most of the small extensions and a fair percentage of the larger ones from earnings from the system after it is in operation. If this be done, the ultimate effect will be lower rates because of the reduced charges on account of being relieved of interest and sinking fund requirements. Corresponding rate reductions will in effect be a division of this surplus with the customer.

Long time budgeting is equivalent to long distance planning, and will keep the utility prepared to meet future demands and at the same time will enable it to appropriate to specific projects net income accruing from year to year as a result of operations. This can be done only through a constructive expansion program which must be carried out without interference.

Accounting.—Accounting is an extremely important phase of the management of the municipally owned utility and should be in the hands of a competent staff of accountants. Above all the commission and its manager should not fool themselves regarding the exact financial status of the utility. Although not required by the Oregon laws to do so, we believe that it is to the best interest of the utility to use the Uniform System of Accounts prescribed by the Public Service Commission.

No department can be any better than its personnel. Therefore, the commission should avail itself of the specialists available, in the conduct of its business and in the meeting of new problems incident to its expansion program. A few of these experts who are readily available and who can be of great value are auditors, consulting engineers, economists, financial authorities, geologists, lawyers, rate engineers and testing engineers. As occasion may arise for the knowledge of these specialists, their employment will be found one of the best investments the utility can make.

Acknowledgment. — The foregoing paper was presented at the recent municipal finance conference held at the University of Oregon, in cooperation with the League of Oregon Cities.

Testing Cast Iron Pipe

Apparatus Used and Methods Employed

By WILLIAM R. CONARD
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THE apparatus used for testing primarily consists of a hydraulic press; the machines for the physical testing of the metal; and the tools (caliper, gauges, hammer, etc.), which the inspector uses in connection with the visual examination of the pipe. The hydraulic press is a piece of apparatus which seals each end of the pipe, fills it with water, exhausts the air, and then by a pump acting usually through an accumulator raises the water pressure in the pipe to some specified amount. The other apparatus for physical testing of the metal usually consists of a tensile and transverse testing machines in which prepared pieces of iron, usually called test bars, are subjected to tensile and transverse stresses to determine strength and resiliency. The inspector's tools are his pick hammer, caliper for measuring the thickness of the metal and other dimensions, and gauges to further calibrate the different dimensions of the pipe and fittings.

Methods Employed.—After the pipes are cleaned and chipped and have undergone examination on the skids for dimensions, quality and appearance, they are put under hydraulic pressure and tested for strength and porosity. This is called in the specifications the "hydrostatic" test. There was a time in pipe making when this test was applied in an adequate manner to all sizes, as it still is in the case of larger pipe; the present practice in testing pipe 3 in. to 20 in., however, can only be termed adequate if the specified pressure applied for as short a time as 10 seconds is considered satisfactory. The reason why the pressure is held for such a short period of time is that the facilities for this part of the operation of producing pipe has in most cases been lost sight of in the endeavor to keep up to quantity production, and the necessary room and apparatus for the testing have not been provided for by the manufacturer to the same extent as have the facilities for the other manufacturing operations. On the importance which the purchaser attaches to the hydraulic test, would therefore depend the period of time to be specified that the pipes are to be held under pressure before they are accepted.

The apparatus for demonstrating the physical properties of the iron are usually the standard tensile and transverse testing machines fitted up to take the type of test piece which the specifications call for. The pieces for the tensile tests have approximately a 1 sq. in. cross sectional area, and for the transverse area 2 in. by 1 in. by 26 in.

The inspector's tools are primarily the pick hammer with which the pipes are tried for hardness and indications of and visible defects are explored; the caliper, which is used to measure the thickness of metal, and sometimes other dimensions, and gauges for checking dimensions. Other tools are measurement rules, steel tapes and minor special or odd tools used at intervals as a check.

Some purchasers require a check on the chemical components, and where this is required, the inspector has to have sufficient knowledge of irons to know something of the grades by visual examination, and to tell whether the proportions are right when the foundry analysis is made.

One of the most important functions of a proper testing of cast iron pipe is the inspector's visual examination of the individual pipe, and to be able to perform this part of his work properly requires that he have a good working knowledge of molding, pattern making, machine shop practice, chemistry and, most important of all, the causes and effect of the things that can and do happen in the manufacture of the pipe. Also, and of considerable importance, a knowledge of the principles of engineering as applied to the uses to which the pipe are to be put. All of these, together with good common sense and sound judgment, enables the inspector when he examines a pipe or special to quickly determine the suitability of that particular pipe or special for the use for which it is intended.

Other duties connected with the inspection or testing are for the inspector to witness the tension and transverse tests, to determine the general physical properties of the iron, maintaining a check on the producing the test pieces for these tests as well as the chemical analysis, and to maintain supervision over the coating as well as the weighing. Many purchasers also keep the inspector informed as to their requirements on delivery so that he being directly on the ground sees that these requirements are adhered to.

One of the last tests of pipe before loading for shipment is to weigh the individual pipe or casting to see that it comes within the limits for its size and class; if it is too light, it is either placed in a lighter class or put among the culls, and if too heavy it is either marked down to the top limit, placed with a heavier class, put in the culls, or if too far out of the way it may be scrapped.

Summary.—It is difficult to describe by written word the details of the testing of cast iron pipe, and to describe the methods used, for there are as many as seventy odd things that may make a pipe unfit for use, and therefore the individual visual examination is a most important part of the testing, and much depends on the extent of the training and the experience of the inspector, and his attitude toward his work. If he has had the training, is interested in what he is doing and why he is doing it, and assumes an unprejudiced attitude to both the material and those producing it, and also is willing to place himself in the position of trying to learn something each day, the purchaser who is having the material tested by such an inspector can usually rest easy and feel pretty well assured that his interests are being properly looked after. It is to be conceded that unless the work of inspection of pipe and castings is honestly and intelligently performed that the purchaser is spending money uselessly.

Acknowledgment.—The foregoing is an abstract of a paper presented Sept. 19 at the 48th annual convention of the New England Water Works Association.

Cost Accounting for Sewage Works

The System of Urbana-Champaign Sanitary District

By GUS H. RADEBAUGH
Manager, Urbana-Champaign (Illinois) Sanitary District

RECORDS of costs of operation of sewage treatment works are of vital importance, in my opinion, with regard to the successful future of the subject in which we are so much interested.

It is not my desire in this short paper to present methods of cost accounting than can be used and adopted in the management of all treatment works. I do appreciate, however, that the engineering profession and the industries associated with this problem will be penalized by a public which is desirous of clean streams, better health and a keener respect for the great out-of-doors, if this group and similar organizations neglect the importance of a standardized national code of cost accounting for the construction and operation of sewage treatment works.

It is my opinion that community progress comes only to those municipalities which are fortunate enough to accept correct and economical design of public works, and which have public leaders who believe in and see to the intelligent expenditures of public monies. This and similar associations can do much to encourage and assist in establishing correct standards for our community leaders to follow.

Many of the citizens of the State of Illinois have awakened to their individual responsibility with relation to the pollution and destruction of the state's beautiful rivers, and are accepting the challenge of civilization by proper disposal of sewage and industrial wastes. Illinois has 22 sanitary districts organized under the Law of 1917 and 2 districts organized under special acts, the

Chicago and North Shore Districts. It is established that 135 cities and towns in the state are recognizing in some manner the importance of treating their waste.

The Urbana—Champaign District.—The Urbana and Champaign Sanitary District, organized May 24, 1921, was the fifth municipality in the state to take advantage of the Law of 1917. This district consists of a rectangular area with a maximum width of 2.5 miles and a length of 4.0 miles. The total area within the Sanitary District is 5456 acres or 8.53 square miles. The total population is now 38,540. The density of population for the district in 1930 is estimated at 6.4 per acre; by 1960 this may increase to 12.8 per acre. The present assessed valuation is $27,150,053. A $500,000 bond issue was voted Nov. 28, 1922. The total sewage treated the past four years is approximately 5,346,000,000 gal. an average of 1,336,525,000 gals. per year, or 3.66 million gallons per day.

A complete report covering operation and management of the district's affairs has been published annually, giving to the tax payers a financial history of the operation of their project. A yearly audit is made of the income and expenditures by a public accountant.

Essentials of Cost Accounting system.—In designing the cost accounting system used by this district several standards were established as essentials in maintaining an accurate record. These essentials were:

1—Any system used should be substantiated by the budget method of financial control.

2—The system used should make possible without excess labor a monthly operating balance sheet.

3—All expenditures should be properly charged to accounts as established by the tax levy ordinance.

4—The tax levy ordinance should be divided into specific accounts and amounts—thus

B-2 Employee's wages, $00.00.
B-3 Power and coal, $00.00.
B-4 Water, $00.00.
B-8 Grounds, $00.00.

5—Voucher checks must be signed by two officers of the Board and the Treasurer.

6—No account should be paid unless an itemized invoice is issued to the District covering the item of expense.

7—A yearly certificate of audit must be received by the Board from a public accountant.

With the above essential as the guide, the following is the adopted accounting program:

The Accounting Program.—The Treasurer of the District, under $50,000 bond, receives the monies collected from the levy by the County Treasurer and deposits same in the District's depository. The Treasurer makes a monthly report to the trustees of receipts and expenditures.

The manager receives the invoices for payment, arranging them into the proper accounts as established by the tax levy. They are then presented to the board at a regular meeting for approval or rejection. When the approval is made and the authorization is made a part of the minutes of the board meeting, a voucher check is drawn in favor of the invoice, the number of the check being entered on the invoice, it then being filed for audit. The check is signed by the President and Clerk of the Board and by the Treasurer. The Treasurer makes the entry in a distributional ledger. The manager enters the paid accounts under the proper distribution. The manager also presents to the Board a monthly appropriation analysis or budget control sheet, which shows at a glance the working balance of the various accounts, expenditures this month, expenditures to date, appropriation unexpended, total account balances and the bank balances for the month. This monthly appropriation analysis has been found to be of paramount importance in the proper control of all expenditures. The accounts of this district have the following headings:

	For Interest and Bonded Indebtedness	
A-1	Interest due and payable June 1, 1929	$00.00
A-2	Interest due and payable Dec. 1, 1929	$00.00
A-3	Principal payment due and payable Dec. 1, 1929	$00.00
	For Other Corporate Purposes	
B- 1	Salary of Ofc. & Atty. Fees	$00.00
B- 2	Employee's Wages	00.00
B- 3	Electric Power & Coal	00.00
B- 4	Water	00.00
B- 5	Repairs on Equipment	00.00
B- 6	Supplies & New Equip.	00.00
B- 7	Lab. & Ofc. Exp.	00.00
B- 8	Ground Maintenance	00.00
B- 9	Secondary Sett. Tank	00.00
B-10	Contingencies	00.00

Cost Data.—The district published reports show the following cost data:

Costs Per Capita

	1925-26	1926-27	1927-28	1928-29
Operation	$0.42	$0.48	$0.35	$0.38
Total	1.74	1.62	1.54	1.53

These figures represent all expenditures passed for payment by the Board of Trustees such as bond interest, bond retirement, new construction, engineering fees, legal costs, plant operation labor, etc., in fact every expenditure incurred by the district.

Conclusions.—The general public demands correct and standardized cost accounting for sewage treatment works.

In the opinion of many engineers cost comparison of works operation is at the present time difficult due to the varieties of interpretation of operation costs.

The strongest force tending to stimulate construction of sewage treatment works is the intelligent and honest management of those already in operation.

In my opinion the Izaak Walton League of America and the American Public Health Association have done more to prepare the public for the acceptance of correct sanitation than all other agencies combined.

With the above conclusions as my forerunner, I respectfully present to this convention this recommendation:

"That this organization recommend to the officials of the Federation of Sewage Works Associations that a national committee be developed to standardize a national code of cost accounting adaptable for sewage treatment works operation."

Acknowledgment.—The above is a paper presented June 21 at second annual meeting of the Central States Sewage Works Association, and printed in the July Sewage Works Journal.

State Sanitary Engineers Hold Phenol Conference

W. L. Stevenson, chief engineer of the Pennsylvania Department of Health, and E. S. Tisdale, chief engineer of the West Virginia Department of Health, met Ohio's chief engineer at East Liverpool, Ohio, July 9, on an important conference following which several joint inspections were made, "Ohio Health News" states.

The city of East Liverpool has provided new devices which are in the experimental stage and with which it is hoped to demonstrate the feasibility of minimizing, if not eliminating, bad tastes in Ohio River water resulting from accidental discharges of phenolic materials from by-product coke and other works where such wastes are being treated. This effort on the part of East Liverpool is a follow-up of work done in cooperation with the health department engineers of the other states in the Ohio River interstate stream conservation agreement. Practically all by-product coke works in the Ohio River drainage area have provided complete treatment devices for eliminating phenol, these devices being of varying types. However, it has been recognized that occasionally there may be accidents resulting in spills of the wastes for a few hours, which might occur a few times during the year.

In order to cope with this situation studies have been under way, chiefly at the Ohio Department of Health laboratories, in the way of research upon ways and means to combat the phenol at the water purification plants. One of the processes, demonstrated at the East Liverpool water purification plant, consists of superchlorination with chlorine gas and dechlorination with sulphur dioxide gas. The meeting at East Liverpool perfected notification arrangements whereby prompt notice would be available to the East Liverpool chemist and others downstream so that steps could be taken in the effort to eliminate the phenolic tastes from spills. The East Liverpool meeting was also attended by the district engineer of the Pennsylvania Health Department located at Pittsburgh. City officials present were: service director, A. W. Moore; water works clerk, F. K. Robinson and city chemist, T. H. Larkins.

Testing Large Meters in the Field

Methods with Freeman Nozzles and with Previously Calibrated Meters

By R. E. FERGUSON

Assistant Superintendent, Hersey Manufacturing Co., South Boston, Mass.

TESTING by the use of the Freeman nozzle is mostly confined to laboratories of insurance companies, pump manufacturing companies and universities. If one has an unlimited flow of water, there are many advantages of the nozzle test over the tank and scale tests. For instance, the range of flow is easily controlled, the duration of the test is not confined to a few hundred cubic feet, and if the tests are conducted in a careful manner, they are very accurate.

Testing with Freeman Nozzle.—Figure 1 shows an 8 in. meter in a nozzle-testing machine at the Lowell Water Department, Lowell, Mass. As this is a 6 in. machine, and we wanted to test an 8 in. meter, we used on the inlet end of the supply a 6 in. x 8 in. adaptor and about 12 ft. of 8 in. straight pipe. On the outlet end of the meter, we used an 8 in. x 6 in. adaptor, the control valves and about 8 ft. of straight 6 in. pipe, with the pizometer and nozzle on the end. This straight piece of pipe ahead of the pizometer was sufficient to straighten out all the eddies and current induced by the change in pipe sizes. The pressure in the pizometer was regulated by the three valves, 6 in., 2 in. and 1 in. In running a test, we opened the larger valve until the pressure was within about ½ lb. of that desired, and then we used the small valve for the finer adjustments. With this small valve, we could also control any slight fluctuation of the pressure. During the test, the pressure was checked in two ways. First, by the spring gauge which was attached to the pizometer, and secondly, by the mercury column which was also attached to the pizometer, through the same connections as the spring gauge. The spring gauge is graduated in 1/10 of a pound, and the mercury column in 1/5 of a pound. On this test we used the 1 in. and 4 in. nozzles. The rates varied from 75 g.p.m. to 2,880 g.p.m. The pressure at the nozzle used was from a minimum of 6 lb. to a maximum of 29 lb. The pressure on the inlet side of the supply line was 70 lb.

Figure 2 shows a close-up of the meter and a mercury column to check the loss of pressure across the meter and the method of attaching the mercury column to the meter. It also gives a better view of the flow regulating valves. I might also add that on the inlet end of the supply pipe, an air release valve was installed. The water was supplied through about 40 ft. of 6 in. pipe to the test machine and was a take-off from a 24 in. main. The water was discharged into the pump well so there was no waste of water.

Method with Previously Calibrated Meters.—Figure 3 shows an installation of a 4 in. compound with a 4 in. bypass and the proper valves installed so that the meter repair man can test and repair the meter without interference with the consumer's water supply.

In some cities, these bypasses are the same size as the meter. That is to say, if there is a 4 in. supply line, the bypass around the meter is a 4 in. This bypass flow is controlled with a gate valve which is locked tight with a chain and padlock, the only key to which is held by the water department, and in some cases, seals are used. In this picture, you can see the test meter attached direct to the meter with a 2½ in. hose. In some cases, a test tee is installed in the line between the outlet end of the meter and the gate valve. This installation, as you can see, has a 2 in. gate valve attached to the meter below the hose connections, the advantage of this being that when making a test, the valve on the inlet side of the meter does not have to be shut to make test connections. If it is necessary to shut down the valve to make test connections, the incrustation from the side of the valve may be broken and lodged in the meter stopping same. This would necessitate opening the meter and cleaning it out before conducting a test, which in the case of a disputed bill would make the test almost worthless.

The illustration also shows the meters which we have used a good many years for making this test—a 3 in. velocity meter for the large flows, and a ¾ in. disc meter for the small flows. These two meters are connected to the meter to be tested with a 2½ in. high pressure hose, the flows through the 3 in. meter being controlled by a 3 in. quick-closing valve, and the flows through the small meter being controlled by the ¾ in. angle valve on the side of the 3 in. meter to which is attached the ¾ in. When using the small meter, the 3 in. gate is closed, and vice versa. The 3 in. valve is a quick-closing valve which enables the tester to close the meter more accurately than by a screw stem valve. The rate of flow is controlled by only partially opening the quick-opening valve, and, with a little experience, the tester can gauge his flows very close to the desired rates. Of course, he checks his flows with a stop-watch. In some cities, different sized orifices are used to control the rate of flow, but of course, as the pres-

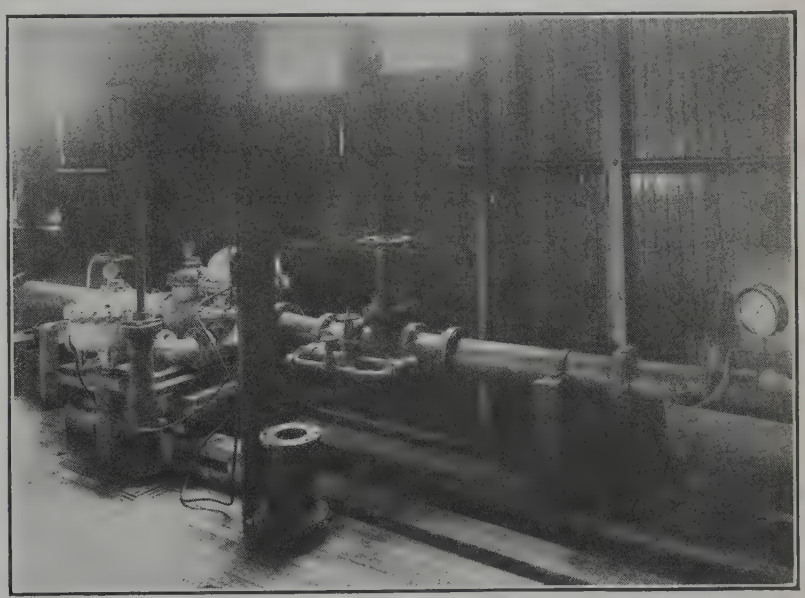


Fig. 1—Installation of 8 In. Meter in the Freeman Nozzle Testing Machine

sure varies in different localities, so will the rate of flow.

In some cities, where they test their large meters at least once a year, the engineer in charge runs what he calls an up and down test. This is run by opening and closing the controlling valve, slowly, during the test so that during the test the flow will vary from the minimum to the maximum rate of the test meter. This almost invariably not only covers the average rate of consumption, but the small night flow and the peak load.

In testing large meters with this apparatus and with from 15-20 ft. of hose under 50 lb. pressure, one is able to test flows as large as from 450-500 g.p.m., which in all ordinary cases is ample. Of course, for the low flows, for which the ¾ in. or 1 in. meter is used, one is able to test the minimum rate at which the meter to be tested is guaranteed.

Why Velocity Meter Is Used.—There are two reasons for using the velocity meter. The loss of pressure is very low at high rates, and at the same time the velocity meter will pass sand and small particles of dirt without interfering with the registration. There is also a strainer on the bottom of the measuring chamber that will stop foreign matter which is large enough to retard registration. I am not inferring that most water departments have more or less sand in the water, but in running these tests, especially on flows larger than the average consumption, if there is any accumulation of sand or dirt in the pipes at all, it will be drawn through the test meter. Of course, this is not true of the smaller rates of flow through the ¾ in. disc meter.

In testing any type of compound meter, it has been our practice to test

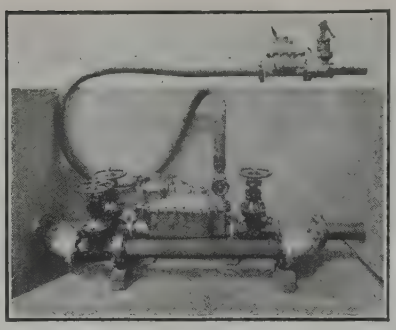


Fig. 3—Installation of 4-in. Compound with Bypass and Test Meters Attached

the smaller flow first, so that if there is any error in the meter it can be segregated. If on testing the bypass meter, it is found to be in error, this error is corrected before running flows that are registered on both the main line and bypass meters.

We have no specified rates of flow at which we test meters in the field, as we allow the superintendent to designate the test rate he wishes us to run, because in a good many cases, the superintendent has a very good idea of the average rate of consumption through the meter. Before making these tests, the test meter is tested in our testing department and the test card attached to the meter before it is shipped.

Setting Meters.—Before closing, I would like to say a few words on a subject not of testing, but which is very closely related to it, i. e., pits in which the meters are set. I have seen meters set in pits so small that the top of the pit had to be removed before one could hook up the test apparatus. I have seen a meter set with a 3 in. gas pipe crossing over the top at right angles and clearing the meter by not over 6 in. In a number of cases, meters are set in pits so narrow that a man could not remove the meter bolts except with a socket wrench or a hammer and chisel. Of course, this is unavoidable in a good many cases owing to other underground conditions, but if the man in charge of building meter pits kept in mind the fact that the meter might eventually require repairs, and that in all probability the work would be done in the pit, I believe we would find the pits larger. If the meter cannot be set without the cover being close to the top, dig the pit 18 in. or 2 ft. below the bottom of the meter, and if possible, have a drain in the pit. This will not only help the repair man, but also will assist in keeping the registers cleaner.

Acknowledgment.—The above is an abstract of a paper presented Sept. 18 at the 48th annual convention of the New England Water Works Association.

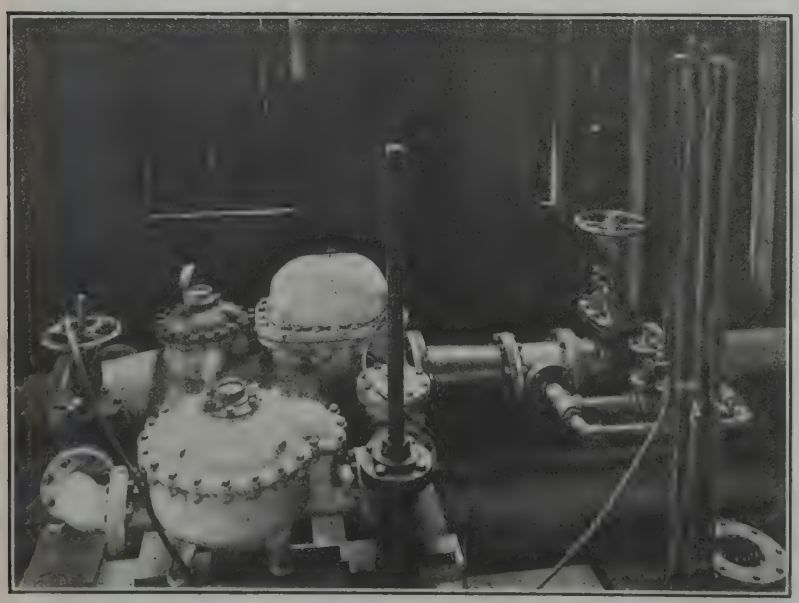


Fig. 2—Showing Mercury Column to Obtain Loss of Pressure Across the Meter

Field Mice Attack Trees on Water Shed

An effective campaign against the field mice, which have been attacking a large number of the 40,000 to 50,000 Scotch pine trees planted three years ago in the 40 acres of forestation for the protection of the watershed at Lock Raven, has been started by Water Engineer Edward G. Rost of Baltimore, Md.

The mice have been attacking the trees in the fall and winter months after the vegetation starts to die and they can find nothing else upon which to feed.

The damage to the trees was discovered after the needles on the trees had turned brown and there was other evidences of decay. While the attack has been made chiefly upon the young trees the mice have not overlooked some of the older and taller ones.

Experts from the United States Department of Agriculture were called in consultation and after an examination stated they believed the trees were victims of spittle bugs.

A later examination by Mr. Rost disclosed holes at the base of the trees. Upon removing some of the soft dirt with his hands Mr. Rost found the bark at the roots had been eaten away and this led him to believe the destruction was due to mice. The bark on the trunk of the trees also had been eaten in places by the rodents.

After the setting of 100 wire traps failed to render the desired effect Mr. Rost held a conference with F. N. Jarvis, in charge of the Eastern Rodent Control District of the Biological Survey of the Department of Agriculture, and it was decided to place poisoned oats in the runways on the watershed near the trees for the purpose of exterminating the mice. It is known the rodents will eat the oats in preference to any form of vegetation and it is hoped by this means that the offenders will soon be exterminated.

Two-Main System of Water Distribution

Experiences in Chicago Show System More Economical Than the Single Main System

By J. B. EDDY
Engineer, Water Pipe Extension, City of Chicago, Ill.

THE city of Chicago has adopted a definite policy regarding the use of the two-main system of water distribution. While not used exclusively for all new installations, its advantages are kept in mind and whenever the benefits to be derived warrant it, the two-main system is used. No hard and fast rules have been adopted, each installation being considered on its own merits; however, in car line streets, wide boulevards, newly widened traffic arteries and in streets 80 ft. wide, with fronting lots, two mains are laid. The first street in which two mains were laid in place of one was a "downtown" business street.

Replacing Old Main with Two New Ones.—During the years from 1907 to 1912 inclusive, pitometer surveys were in progress in and adjacent to the central commercial and business section (known as the Loop district) of Chicago. Elimination of underground leakage was a part of this work, special attention being given to streets about to be paved. In this section of the city many services had been abandoned where large buildings occupying a number of lots replaced a number of smaller buildings. These abandoned service pipes, of lead, were often battered shut where cut near the curb, many opened up from the effect of pressure, and sand washing quickly enlarged the opening. The result was usually an underground unobserved leak—growing as time went on until many were discharging the full capacity of the service. This section of Chicago has a sandy subsoil over which usually were placed, as the street grades were raised, cinders or other fill, making easy the escape to the sewer of underground water. Under such conditions it was necessary that the water system be thoroughly overhauled prior to repaving.

The 6-in. main in Randolph St., La Salle St. to State St. (three blocks), was tested for underground leakage in 1910 previous to repaving. The tests were made at night because of the density of daylight traffic and the inconvenience to the public which would result from a shutoff made during the daytime. Underground leakage amounting to approximately 200,000 g.p.d. was measured.

This 6-in. pipe was laid about 1855 as a part of the original cast iron system. Later, filling placed in this street gave the pipe a cover of about 10 ft. Street car tracks were laid over the 6-in. pipe, the location of the main at State and Randolph Sts. being about 1 ft. south of the center line of the street. After a comprehensive study had been made it was decided to replace the old 6-in. with two new mains, one 12-in. to extend from State St. to La Salle St. adjacent to the north curb, and one 8-in. to be laid adjacent to the south curb in blocks requiring services.

Considerations in Installing Two Mains.—The reasons for this decision were as follows:

1. It would be very costly to locate and stop the underground leakage.
2. Traffic would have to be diverted to other streets while repairs were being made, which would greatly inconvenience the business houses on this street and the public generally.
3. Additional supply, both for fire and commercial use, was necessary.
4. Service pipe stubs not in use could be abandoned.
5. Live services could be retapped to the new mains, thus eliminating all piping beneath the car tracks (except at cross streets), making less service pipe to be maintained and reducing the electrolysis, known to be active in this street.
6. Future large service pipes for fire and commercial use could be installed at greatly reduced cost.
7. The mains near the curb lines could be maintained with little inconvenience to the public and at less cost than the old main beneath the street car tracks.
8. No main would be laid on the south side of the street between La Salle St. and Clark St. because of no service requirement. Fire protection in this block would be furnished from the 12-in. main.

The factors given greatest weight in the conclusion reached were:

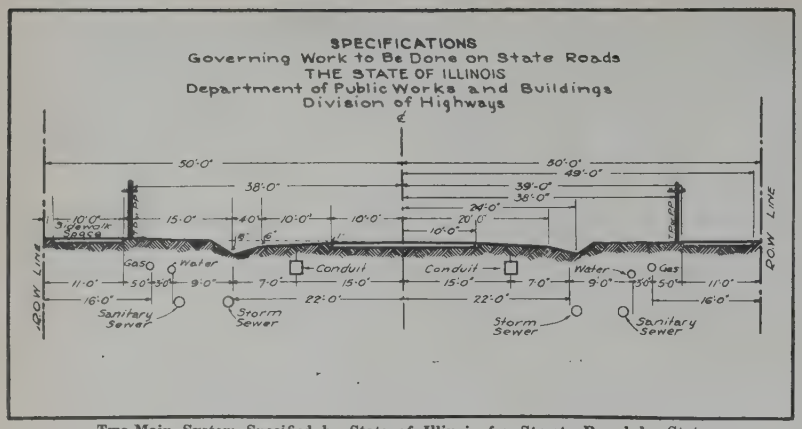
1. Public convenience.
2. Future maintenance cost.
3. Additional supply.
4. Elimination of underground leakage.
5. Electrolysis mitigation.

The 12-in. and 8-in. mains were installed in 1910 and this marked the beginning of the use of the two-main system in Chicago.

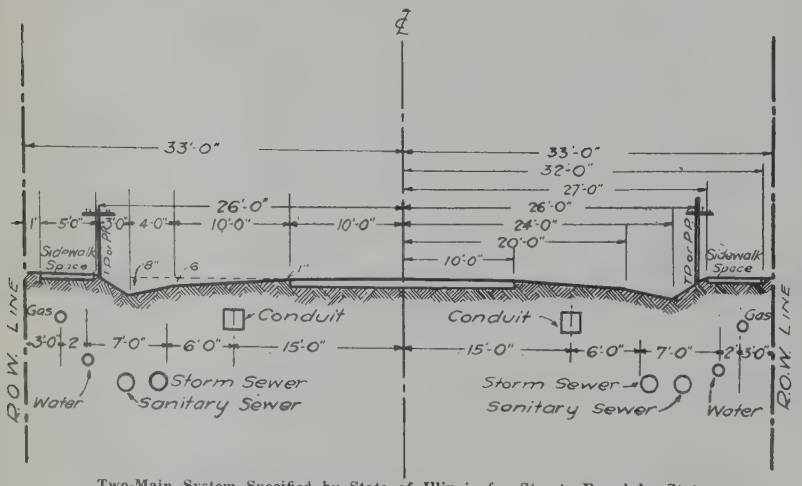
Since this work was done, similar investigations have been made in other loop streets until now many of the streets in the downtown section have two mains.

Water mains in the loop are not laid in the sidewalk space because this space is usually occupied for storage and other purposes. Variations of the two-main system exist, mains being laid in alleys, only one main being laid where service requirements are such as to make two mains unnecessary. In some streets having street car tracks the old

Trenching on Michigan Blvd. in Chicago Showing the Space Between the Pavement and Sidewalk in Which the Main Was Laid



Two-Main System Specified by State of Illinois for Streets Paved by State



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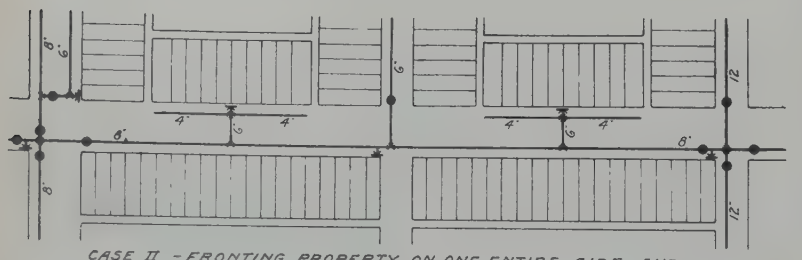
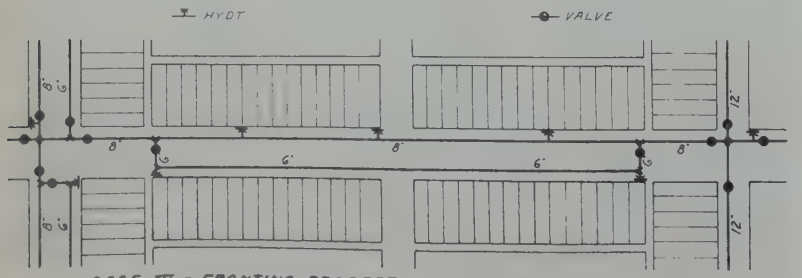


Plan for Mains for Fronting Property on One Side of Street and Parts of Other Side of Block



Plan for Mains for Fronting Property at One End of Each Block, Siding Property at Other End

main was in such a location as to be readily accessible. In such streets a second main was laid near the opposite curb, the old main overhauled, and the services in use to the opposite side of the street reconnected to the new main. All service pipe stubs were shut off at the main.

Laying Mains in Michigan Blvd.—In 1922 the roadway of Michigan Blvd., from Roosevelt Rd. to 33rd St., was widened about 7 ft. on either side and paved. The old 6-in. water main was located about 10 ft. west of the center line of this 100-ft. street, and had given much trouble when repairs were made and when large services had to be installed due to a change from residential to commercial occupation because of the danger to workmen and the inconvenience to motorists. Additional capacity was needed in this street.

It was decided to abandon the old 6-in. and install two 8-in. mains, one on either side of the boulevard. Trenches were excavated by digging machines excepting street intersections, which dug by hand. Each main was laid as near the new curb line as possible. It was necessary to cut the sidewalk for 10,560 ft. of this improvement. In the remainder there was a 7-ft. parking space in which the pipe was laid. The amount of pipe laid was 23,720 ft. and the time required for the work was about four weeks.

Many old service pipe stubs were abandoned.

All live services were reconnected. The cost of this work was $2.95 per foot, the material costing $1.60 per foot.

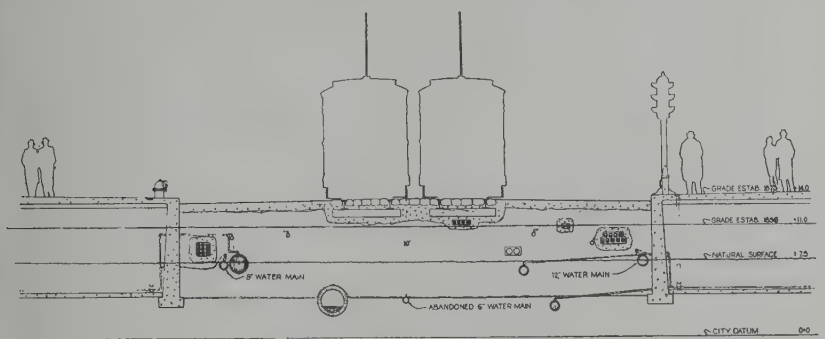
Factors to Be Considered.—Whether or not the two-main system is used in Chicago is not always determined by first cost. It is installed in business streets, car line streets and boulevards because it has been shown by experience that after installation in such streets the two-main system causes less inconvenience to the public and is less costly to maintain than one main with long services.

In all residence streets of less than 80 ft. in width, except state roads, an estimate of cost is made to determine which system shall be installed. However, there are many factors which should be considered in addition to first cost when deciding whether or not to use two mains.

Usually the street pavement is laid a very short time after the water main and service stubs have been installed, and for this reason pressure is being exerted to have all excavated material other than sand or gravel hauled away and sand used for backfill, so that the pavement can be laid immediately following the completion of underground utility work. This provision has been enforced a number of times within the past few years and the cost of hauling away excavated material and hauling in sand, plus the cost of one main and long services, greatly exceeds the cost of two mains back of the curb lines.

Of course, it is necessary that traffic arteries be out of service for repaving as short a time as possible, and sand backfill aids greatly in cutting down the time of making the improvement and insures that the new pavement will not settle over newly made trenches. It does not assure that the new pavement will not be cut to make repairs, and therefore when no main has previously been laid it is better to lay two mains inside the curb lines, which makes the sand backfill unnecessary and places the pipes where they are readily tapped or repaired without going into the pavement. Also, mains and services need not be laid, except crossings, until water again the weak spot has been the wiped joint.

Two-Main Systems for Streets Paved by State.—The state of Illinois requires the two-main system where streets and roads are paved by the state. Standards are provided in the state specifications for arrangement of pipes, sewers and conduits for rights-of-way varying from 50 to 100 ft., two of which are shown. Provision is made that all pipes, sewers, and poles shall be placed outside of a 40-ft. strip which centers on the center line of the right-of-way. The conduits are located so that they clear a 20-ft. pavement but lie under a 40-ft. pavement.



Cross Section of Randolph St. Showing Abandoned 6-In. Main with Existing 12-In. and 8-In. Mains and Utilities

for service and fire protection is actually needed. Streets have been treated in this manner in Chicago with satisfactory results, the paving in some cases having been down for five or six years before water was required in the street.

Causes of Leakage.—In connection with the overhauling of mains and services, prior to paving, it has been found that the lead service pipe is a greater source of underground leakage than the cast iron main. From 1916 to date, 966 service pipe leaks have been repaired which showed a measured leakage of 5,336,000 g.p.d. During the same period 429 main leaks have been repaired which gave a measured leakage of 3,590,000 g.p.d. The service pipe leaks are usually at the wiped joint either at the coupling to the tap or at the stopcock, more frequently at the former.

The point is that the number of wiped joints can be greatly reduced where two mains are installed because service pipes are laid only when and where required and not for every lot. Furthermore, where no trenches are dug crossing the sewer there is a greater possibility that the leakage will show up at the surface since trenches give easy access to the sewer.

In connection with maintenance work, 68,998 service pipe repairs have been made as compared with 41,459 main repairs from 1916 to date. No measurement of leakage has been made in connection with this work, but here

In a number of streets that were being repaved, it was found economical to abandon the old main and lay two new ones. The old main in each case was obsolescent, badly corroded by electrolysis, inaccessible, or it was known that the cost of digging it up to salavge would exceed the value of the pipe. Old mains, where accessible and in good physical condition, are always overhauled before a street is paved, leakage being located and stopped and abandoned services closed off at the main.

Variations of Two-Main Systems.—Many variations of the two-main system may be used. A street may have solid frontage on one side and partial frontage on the other, in which case the plans shown in the illustration may be used.

In some sections of Chicago the two-main system has been used almost exclusively.

Experience in Chicago with the two-main system has been most satisfactory and demonstrates that in the last analysis, this system is more economical under the conditions where used than would be the single main system. The saving in initial cost of service pipe, the lower maintenance cost, the additional capacity, the better fire protection, the reduction of electrolysis, all contribute to economy.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1929 convention of the American Water Works Association.

Filter Material for Sewage Trickling Filters

The American Society of Civil Engineers Committee on Filtering Materials for Water and Sewage Works, which has been investigating this subject for several years has a progress report in the September Proceedings of the Society. The following tentative conclusions are given on testing and selecting filter material for trickling filters:

(a) Material for filter media should be sound, hard pieces with all three dimensions as nearly the same as possible, clean and free from dust, screenings, and other fine material. It should be of as nearly uniform size as possible, and the material should not disintegrate under service conditions either by breaking into smaller pieces or by crumbling into fine material.

(b) In selecting the most suitable material for a given installation from the available sources of material, careful investigation of the several sources of material should be made, including geological inspections of quarries, a study of the facilities for obtaining, screening, and cleaning the desired size of material, and a laboratory analysis of samples selected from the several sources to determine the comparative merits of the several materials as to the probability of the breaking down of the materials under filter service conditions. For this laboratory analysis samples should be selected from the various ledges in the several quarries or from the several possible storage piles.

(c) The investigation of the Committee to date indicates that the sodium sulfate soundness test is the most indicative test for predetermining the disintegrating qualities of the proposed material. Other physical tests, including the determination of specific gravity, the absorption, and porosity, give useful information. Chemical analyses are of value in determining the effect of impurities, such as earthy materials, iron, and sulfur, and, in some cases, lime and magnesium. Micro-structural analyses made by properly qualified examiners may also be useful.

(d) Great care should be taken in obtaining the filter material from a selected source to insure a uniform grade and size, free from dirt and fine matter. There is evidence to indicate that improper screening for size and cleaning of filter material for many of the existing trickling filter installations has been of influence in the deterioration of the filter beds, perhaps more so than the matter of breaking down or disintegration of the individual pieces of filter materials. It appears that proper sizing and cleaning of filter material cannot be obtained without special arrangements for screening and rescreening and perhaps washing of the material either at the source or at the filter plant immediately before placing the material in the filter bed.

Water Works Management

Essentials in Successful Management of a Municipally-Owned Water Works System

By H. E. MOORE
Secretary, City Water Works, Dallas, Texas

FOR the purpose of discussion I shall refer only to the municipally-owned water works system, though in my opinion the holder of any privately-owned franchise of this nature should live up to the same high purpose or forfeit the privilege granted him. No corporation has the right to make a profit from any public necessity unless it honestly and squarely studies the needs of the community supporting it, and endeavors to fill adequately the purpose of a water supply, that is city building.

Three Factors of Community Growth.—The question of water supply has always been a vital factor in human history. No civilization has ever developed without at least an adequate supply of fairly pure water. The modern age was ushered in by the three big factors of community growth, demand for sanitation in its various phases, and industrial development. Fire-fighting facilities I would class in the item of community growth. Under the term "sanitation" we can include both the direct health factors and the more indirect items of aesthetic value such as street cleaning, parks with wading pools and landscaped grounds, and similar demands which any community now makes upon the water supply system. It is not at all difficult to realize that the person responsible for the management of a water works systems has demands upon his abilities and activities which require real consecration to the task at hand. Let me change one letter in the title of my subject and make it read, "The Problem of Water Works Management." This problem is to keep a broad outlook and constantly survey the market for the commodity he is dispensing; to plan for future needs due to growth; to keep his rate schedules intelligently adjusted to the shifting requirements from the super-industry of which his department is a part, building desirable, healthy cities for people and encouraging the industries which supply their need of a livelihood. The need for uniformity of supply, accurate records for the distribution system, an adequate distribution system, and a proper accounting system, are all more or less important parts of the major structure centering about one individual. The wise manager will solve these various needs by selecting competent heads for the different divisions, and then lean heavily upon them. Thus his mind is relieved of a multitude of details and left free to think and plan along broad constructive lines.

Water Department Vital Factor in Growth of Town.—The problem of management is to get a vision of the possibilities and organize the department with a view to placing it in the first rank of leadership for the town which it serves. A well-balanced population center under modern conditions of necessity requires more or less industry to be self-sufficient and thiving. The demand for plenty of pure water for domestic and sanitary uses at reasonable rates is logical and must be satisfied. Right here is the largest source of grey hairs for the manager of a municipally-owned water system. His actions are unfortunately often more or less circumscribed by the political influence of his customers. These customers are ever ready to exercise the voting power in an effort to force cheaper domestic rates, regardless of the economics involved in our rate schedules. The tendency to put water departments under separate boards fairly free from political influence is going to measurably improve this condition. We must be cautioned, however, that with more freedom of action comes greater obligation to use due business principles to keep the domestic end of the rate schedules where they fairly belong from an economic standpoint. Abuse of this feature, with more freedom from the undue influences, will discredit the idea and offset the progress made. An efficient and fairly operated water department under a non-political management will in a few years gain a hold on the minds of a community that no municipal storm can shake. The public always approves efficiency and just dealings in the end. We must admit that most of our troubles from this source are due to a more or less justifiable reaction of the public to our overbearing attitude in the past.

Water Supply a Fundamental Factor in Industrial Growth.—The three fundamental factors of industrial growth are: (1) Cheap and dependable fuel; (2) cheap power; (3) cheap and abundant supply of pure water.

Lying within the boundaries of our southwestern states is enough lignite coal to supply the present and future needs of great industries. It can be obtained very cheaply by any community in this section. Development of this asset has been started on a large scale. In Oklahoma and Arkansas coal fields are high grade steam coal available at reasonable cost. We have cheap fuel oil from our oil fields, and gas for industrial purposes is in extensive use with ample supply. Power and light companies have developed an adequate and dependable source of cheap power for our needs. Now let me ask how many cities or towns represented here have a vision of their water supply system as a vital factor for the necessary industrial growth? It is really the most important of the three named, and belongs to the citizens of the respective communities. As a stockholder in the municipality every resident is interested in this question. It is in this connection that the need for scientific study of the rate schedules in effect exists. The bookkeeping system should include a method to give monthly summary sheets showing a summary of consumption recorded. They should separate accounts into amount-consumed classifications. In addition it should be the function of some one trained in such matters to analyze them and from time to time investigate the idea of adjustment to more equitably distribute costs and make the department function as a civic asset industrially.

Public-Relations Man Needed.—To my mind every water department logically needs a commercial agent or public-relations man whose sole duty is to sell the citizens on their own asset and study just such questions as I am raising. Every large concern selling a public service has a large commercial department with trained employes endeavoring to keep the charges of the concern intelligently balanced to the conflicting demands for meeting all costs and developing more markets for the commodity they have to sell. Of course you can readily understand that in smaller cities all the needs I am enumerating will logically center in the manager himself. This fact emphasizes the importance of putting competent, properly-trained men in charge of the water departments of such places.

Let the thought I leave with you be a resolve to study our water departments with the view to making them fulfill the mission I have outlined. The welfare of a growing town or city is bound up with the proper functioning of its water-supply division on a sound business basis. It is good business for a city to encourage the location of industry sufficient to supply every breadwinner with a job. When factories are seeking locations they weigh carefully the present and probable cost of the water supply necessary to operate in any site under consideration. Specifically I know that the present rate in Dallas has been one of the stumbling blocks to the chamber of commerce program for industrial development. This defect exists generally in this section and should receive our most earnest thought. In my own department we are studying this particular point and trying to map out a forward-looking plan to be the vital factor in our city's growth that the water department can and should be. Due to past circumstances similar to those in the history of large cities especially, most large buildings and factories have their own water supply in Dallas. Now the reason for existence of water works systems is that collectively we can have greater convenience, more ample supply, and better quality, at lower cost than individually. With adequate supply of high quality it is the essence of wisdom to get this business all con-

nected to the one system. Through that increased business the industrial water rates can be lowered below the cost of any individual system and serve to aid rather than retard the proper expansion of the city. We all operate on a "service-at-cost" basis and serving large users means to us ability to better serve the community of which we are so important a part.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 11th annual Texas Water Works Short School.

Well Water Supply

Details That Should Be Considered

By W. KIERSTAD, JR.
Consulting Engineer, Kansas City, Mo.

MECHANICAL equipment of all kinds has been vastly improved during recent years. Well pumps have not lagged behind the procession in the march of progress but have been steadily improved until now equipment is available for the most difficult well pumping problems with many, if not all, of the old operating hazards removed.

Higher efficiencies are attainable, better materials are available for all wearing parts, improved types of bearings are replacing the ones which have been used in the past, more accurate methods of machine work are being employed, better workmanship by mechanical methods replaces much but not all of old craftmen's handwork and improvement in the actual design of critical parts are all the fruits of years of experience and painstaking effort on the part of manufacturers and operators alike to perfect well pumping equipment.

There is a definite and praiseworthy tendency on the part of pump manufacturers to standardize articles which they manufacture in the minutest detail. Such practice results in economy of production, uniformity of product and the most extensive interchangeability of parts possible. Competition in turn brings the saving in cost back to the user of the machinery and the standardization of parts facilitates maintenance.

Conditions Must Be Analyzed.—Nature, on the other hand, cannot be so standardized. Each well project must be carried out and the wells pumped under conditions that by nature are likely to differ to a degree from conditions at any other well site. We find with all of the mechanical improvements and highly specialized machines that now, more than ever before, it is necessary to make a careful preliminary analysis of conditions under which the pumps are to operate if full benefit is to be derived from highly efficient pumps and from the experience of those who have designed, improved and operated them.

Disappointment is sure to follow the blind selection of well pumping equipment just as it would be the purchase of a Packard pleasure car to perform the services of a 5-ton truck of equal value. A pumping unit which suits certain conditions admirably may fall far below the standards set by some other type of pump when installed without giving due and careful consideration to the natural circumstances and limitations surrounding the installation.

Careful Studies Desirable.—Much valuable information as to the depth, thickness and extent of the water bearing formation, the quality of the water and probable yield can at times be obtained from geological reports and from existing wells. Such information should be received and regarded with caution, however, unless the ability of the field to furnish an unfailing supply in the desired quantities has been definitely proven. Domestic wells have frequently been reported by their enthusiastic owners to be "inexhaustible," but which quickly dried up when a well was sunk in the locality and used to furnish water for a public supply. A considerable amount of money may be well spent for investigation, borings and test wells before committing the expenditure of a much larger amount to any public well water supply project.

In the absence of adequate preliminary studies the physical characteristics of the ground through which the well is to be drilled will remain pretty much an unknown factor until drilling operations are far advanced or even completed. Soft caving ground may be encountered for which support must be provided. Strata of mineralized water may be passed through which have to be sealed off from the desired supply, boulders or non-uniform material may be encountered causing a crooked well or numerous other difficulties may arise which affect to an important degree the type of well to be constructed, drilling methods and equipment to be employed and at last the pumping machinery to be installed.

Underground velocities vary widely, depending upon the fineness of the water bearing formation. The velocity in turn has a material affect upon such well characteristics as yield, drawdown, sand content of the water pumped and also upon the number and spacing of the wells which a given district will support or which will be needed for an adequate supply.

Pumping Rate and Water Level.—This depth to water varies from a few feet to 1,500 ft. or more but the approximate depth to the desired water bearing stratum is generally a matter of common knowledge in any locality. The development of the first well or the test well will reveal accurately the level to which the ground water will naturally rise during different rates of pumping. These relations between pumping rate and water level may not remain the same over a period of years, particularly if ample provision is not made in the development process to prevent packing of sand and fine material around the strainer but it is largely upon this initial relation and knowledge of the methods of development that the water supply engineer must base his judgment, seasoned with experience in other localities, as to the best type and size of pumping unit.

Selection of Pumping Equipment.—It will always prove advantageous to defer the selection of pumping equipmene until after the well, or at least one well where a group is to be drilled, has been thoroughly developed. Unless this is done equipment unsuited to the conditions will probably be purchased and unnecessarily high operating costs will folow. There is a tendency on the part of many at first thought to select pumps for a higher head or of larger capacity than actually needed. Such a tendency is prompted by a desire to provide amply for extreme conditions of head and pumping rate, particularly in view of the low additional cost of larger pumps.

It would be far better, however, in endeavoring to provide an ample supply of water to drill two or more wells, pumping a nominal amount of water against a low head from each than to overtax a single well with a large sized and generally over-designed pumping unit. By so doing one often defeats his own purpose, causing the well to fail altogether by clogging on account of the high rates of flow or at least finding that the cost of pumping water is unreasonably high, due to low operating efficiency.

It is, furthermore, too frequently the practice to continue using a pump until because of wear and tear it fails to lift a sufficient quantity of water to meet the demands of the city and in such cases where an over-sized pump was originally installed the cost of power for operation at partial loads will be found to have increased to an excessively high figure before the much needed repairs are made.

Where a plunger pump is operated at a rate above the yielding capacity of the well so that it takes air the running of the pump becomes very uneven and the annoyance of rod breakage soon develops. Difficulties almost as undesirable, although not often so costly, are encountered in the operation of over-sized centrifugal or turbine pumps.

Pumps that are employed for pumping water supply wells may be roughly divided into four classes; deep well plunger pumps, deep well turbine pumps, air-lift pumps and centrifugal pumps of the vertical and horizontal types.

Each classification serves a definite field in the pumping industry, meeting particular requirements suited to it better than pumps of any of the other classifications.

Acknowledgment. — The above is taken from a paper presented at the 1929 Missouri Conference on Water Purification.

Re-Sanding the Cincinnati Filters

By CLARENCE BAHLMAN
River Water Purification Supervisor, Cincinnati, O.

After 21 years' service, preparations are being made to re-sand the Cincinati filters.

As originally constructed, the filtering medium consisted of 8 in. of graded gravel and 30 in. of sand with an effective size of .34 mm and a uniformity coefficient of 1.60, and this sand averaged 1.1 per cent soluble in hot hydrochloric acid. The gravel and sand layers were separated by a perforated screen. In 1916 the screen was removed and an additional 6 in. of gravel was added. This brought the sand surface to within 24 in. of the top of the wash water gutter, as compared with 30 in. when the plant started operation in 1907.

Increased Size of Sand.—Examination of the sand every 2 or 3 years has indicated a gradual increase in size and incrustations. In 1928 the sand averaged .50 mm effective size, 1.29 uniformity coefficient, 50.8 per cent acid-soluble, and the distance from sand to gutter top had decreased to 15.5 in. In other words, the original 30 in. of sand had expanded, because of incrustations, to 38.5 in. The composition of the incrustations, as shown by analyses made by the state health department, was as follows:

	Per Cent
Silica	3.5
Iron oxide	4.7
Aluminum oxide	2.8
Manganese dioxide	1.7
Calcium carbonate	83.1
Magnesium carbonate	1.5
Organic, by difference	2.7
	100.0

No decreased filter efficiency has been observed as the sand became more coarse, but re-sanding is in order because of losing sand during the washing process, in which an 18 in. vertical rise per minute is used. Such loss, however, first noted about 3 years ago, has been confined entirely to the winter months. It seems that the greater density of the colder water has a more pronounced flotation effect.

Careful examination of the gravel layer, strainer system and underdrains has indicated that everything was in satisfactory condition, and a complete reconstruction of the filter beds is deemed unnecessary. It is not intended to disturb the gravel, nor remove all of the old sand.

The degree to which the old sand left in the filters will mix with the finer new material has been studied experimentally. One square foot areas, of a filter were blocked off and excavated to the gravel, and various depths of old and new sand were placed in these boxes, following by washing rates of from 18 to 24 in. per minute. It is evident that more or less mixing occurs, and that the new sand to be added must be somewhat finer than is finally desired in the re-sanded filters.

How Re-Sanding Will Be Done.—The plan decided upon is as follows: The reconstructed filter bed will consist of the present 14 in. of gravel and a 28 in. layer of sand, and the surface of the sand is to be 26 in. from the top of the wash water gutter. At least 12 in. and probably 16 in. or more of the sand bed will consist of new sand. The upper 12 in. of the finished filter, after washing, should show an effective size of from .34 to .38 mm. with a preference of not below .36 mm.

Because of long and efficient service obtained from the present filters it is deemed advisable to re-sand with material from the same source, namely Ohio River sand. Costs also strengthen this opinion. Fine Ohio River sand will cost us $1.60 per ton delivered, whereas sand from Youngstown and from Illinois has been quoted to us at $6.29 and $6.90 per ton delivered.

The effective size of Ohio River sand ranges from .24 to .27 mm. Laboratory studies have shown that by screening such material we are able to produce a sand which meets our requirements of .34 to .38 effective size, and 1.30 to 1.50 uniformity coefficient. The desired fraction was that retained between two screens having openings of 0.97 and 0.29 mm. respectively. Approximately 73 per cent of the crude sand was thus rendered fit for use, with a wastage of 8 per cent pebbles and 19 per cent silica dust. It was also found that the sand should be dried before screening, otherwise too much of the fine material was prevented from passing through the lower screen.

Drying and Screening Sand.—The grading of the crude sand therefore requires both drying and screening equipment. A rotary sand dryer heated with a kerosene burner was purchased, and after some alterations this was made to function satisfactorily. For screening the sand we have purchased a W. S. Tyler two-surface inclined electric vibrating screener. Two 4 ft. x 5 ft. screens are used, namely Tyler's No. 817 Ton Cap for the upper screen, and Tyler's 35 mesh, 0.013-in. opening steel screen for the lower surface. When inclined, the effective opening of these screens are equivalent to the opening of the laboratory screens which were used in horizontal position.

Preliminary trials with this apparatus produced sand averaging .345 mm. effective size and 1.51 uniformity coefficient; which seems to be just about what we require. Should screening on the large scale produce a somewhat finer or coarser product than anticipated, a change in the angle of screening will at least partially rectify the deviation. The measurements of the upper 12 in. of the new sand bed in the finished filter can also be controlled, within limits, by adding somewhat more or somewhat less than the 16 in. of new sand which it is expected will be needed in each filter. Thus two points of adjustment are available for correcting any differences between laboratory and actual results in practice.

That the re-sanding of the filters is an undertaking of some magnitude is apparent. To place 16 in. of new sand in the filters, assuming a wastage of 30 per cent in the screening process, will involve the drying and screening of 2,800 cu. yd. of sand, or about 3,800 tons. About the same amount of old sand must be removed from the filters and transported about 900 ft. to a waste pile. It is planned to do this with a hydraulic sand ejector and thence through a 4 in. pipe. A three-floor shed will be erected to house the drying and screening equipment. The sand will be unloaded from the hopper-bottom cars by means of a portable conveyor, which also will be used to elevate the sand to the dryer on the top deck of the shed. The dried sand will spill into the hopper of the screening machine on the second deck, and from here the 3 fractions of sand will be chuted into 1-ton industrial cars on the ground floor.

Acknowledgment.—The foregoing is a paper presented at the 8th annual Ohio Conference on Water Purification.

New York State Sewage Works Association to Meet at Schenectady

The fall meeting of the New York State Sewage Works Association will be held Oct. 19 at the Hotel Van Curler, Schenectady, N. Y. The program follows:

9:00 A. M.—Registration.
9:30 A. M.—Short description of Schenectady Sewage Works and General Electric Co. Industrial Waste Disposal Plant—Morris M. Cohn.
10:00 A. M.—Inspection trip to described plants.
12:00 Noon—Meeting of Executive Committee.
12:30 P. M.—Luncheon—Address of Welcome—Mayor Henry C. Fagal.
2:00 P. M.—Business Session.
3:00 P. M.—Technical Session (Papers, Discussions) "Present Status of Sewage Treatment in New York State"—C. A. Holmquist.
3:40 P. M.—"The Treatment of Milk Wastes and Whey"—Prof. C. L. Walker.
4:20 P. M.—"The Relation of Designing Engineer to Plant Operator"—H. B. Cleveland.
5:00 P. M.—"The Problem of Interception and Treatment of Buffalo's Sewage"—C. L. Howell.
6:00 P. M.—Dinner.
7:15 P. M.—Round-Table Discussion on Sewage Works Problems.
9:00 P. M.—Candle-light Dancing—Hotel Van Curler.

Round-Table Discussion Topics

Is Imhoff sludge saleable?
What are your odor problems?
Have you a rat menace at your plant?
What are you doing to awaken local interest in your plant?
Have you found a paint to withstand plant conditions?
How do you control your filter flies?
Are there any questions on the operation of the plants you have inspected at Schenectady?
What phases of plant operation need research?
What should this association do to sponsor sanitary engineering courses in colleges of the state?
What do you think of licensing operators?

Service Installation at Detroit, Mich.

By L. J. MONTGOMERY
Principal Water Permit Clerk, Department of Water Supply, Detroit, Mich.

The permit bureau has charge of issuing all permits for the installation of service connections and meters. As the work connected with the installation of water services and meters is an important part of building operations, stringent regulations have been adopted by the board of water commissioners to govern plumbers and plumbing, which are altered from time to time to meet changing conditions.

All master plumbers doing work in connection with the department must have a license both from the department of health and the department of water supply of Detroit, to secure which the plumbers must pass an examination in the art of the plumbing craft. This examination is conducted by the board of examiners of plumbers at stated intervals in the office of the board of health. After the plumber has passed this examination and presents his board of health license, the department of water supply issues its license, for which there is an annual fee of three dollars.

Procedure for Securing Service Installation Permit.—In applying for service installation the plumber is required to fill in a blank form, giving the street name, side of street, between streets, lot number, whether to supply a new or old building, owner's name and address. This he takes to our engineering department to check for main assessment and to secure location of main, size and width of street. When the permit is issued the plumber is given a stake bearing the number of permit. He is required to set this stake just inside of walk at the point where he wishes this department to enter with the service. The permit is then taken to the numbering department, city engineer's office and a house number is secured for the lot which receives the service. A typewritten order, which is a copy of the application, is then sent to the central storage yard and in due time the work is performed by the service installation department. At the time this is done the plumber's work from the house to the lot line is inspected to see that it compiles with the board's regulations as to depth, kind of pipe, etc. Should a delinquency exist, the plumber is notified that it must be corrected before further permits will be issued him. Should the Board desire, his license can be temporarily or permanently suspended.

The minimum size service pipe allowed is that of a ¾ in. This has been found of sufficient capacity to furnish a single house, two-flat, store and flat with tank closets, an adequate supply of water. Four-family flats must have at least a 1-in. service. Large apartments, commercial and industrial properties are allowed any size connection necessary for their supply. All service pipes must be of lead or cast-iron.

When application is made for a new tap the property to be served is checked in our register of connections and if any old connections are found to enter the property they must be removed at the street main. A charge of $20 is made for each old tap removed. When a new tap has been made and service installed this Bureau is notified by the service installation department, which furnishes the location of the stop-box controlling the service. This location, together with size of tap, date of issue of permit, plumber's name and permit number are recorded in ledgers used for this purpose. These ledgers carry a plat of all streets, lot numbers and the feet frontage of each lot. As the plumbers make application for new services these are compared with the records already existing, which serves as a check on the plumbers' information as to the correctness of the property's description to be served. This bureau records a list of all master plumbers, together with their addresses, telephone numbers, etc., so that they can be easily communicated with and notified of any new regulations enacted or any changes made in existing ones.

A record of all paved streets is maintained, giving age of pavement, this being necessary in order to make the charge for pavement cuts, as required by the city charter. A typewritten form, carrying all information on the application for new service, is furnished the rate bureau and these are filed in numerical order, giving permit numbers, and as soon as the tap is made the service installation bureau notifies, who in turn makes out a reader's slip and these slips are entered in the meter reader's books and are reported on by them from this time until the property becomes occupied. When occupied this report is turned in by the rate bureau to this bureau and the order for meter setting is sent to the central yard by us. When the meter is installed this and the rate bureau are notified and we make our records read accordingly.

All water services must be metered. Where services are installed to supply properties outside of the city, it is necessary for the owner to purchase the meter in all cases where we collect the rates. The plumber makes out an application, giving full description of the property to be covered, location of meter, etc., and, upon filing same with this Bureau, he is given a templet.

City Furnishes Meters.—The department of water supply furnishes, without cost, all meters up to and including 1-in. for residential purposes and up to and including 2-in. for commercial and industrial uses. The size of meter allowed is governed by the size and height of building, number of fixtures and the probable need of water. Where application is made for meter of a larger size than that furnished by the board, the owner pays the difference in price. In no case, however, will the Department set, or allow to be set, a meter larger than that which will accurately register the water consumed. The department sets all meters and in the case of large ones performs the work from gate to gate after the remainder of the work has been done by the plumber in accordance with blue-prints furnished him. All meters are sealed after setting. In considering the size of the meter to be furnished by the department, all combination of business and residence property, if one or more floors are devoted to business, is classified as business premises.

All fire lines must be metered, the cost of the meter being borne by the owner of the premises served. An up-to-date record, by means of a card system, is kept of all meter applications and installations.

Acknowledgment—The foregoing is taken from a "descriptive survey," published by the Department of Water Supply of Detroit, Mich.

Dry Square Braided Hemp for Yarning Joints

By OTTO S. REYNOLDS
Traveling Representative, The Leadite Co., Kansas City, Mo.

The merits and economy in the use of dry square braided hemp are so evident at this time that many water works engineers and superintendents specify it on all bell and spigot work. There are several hemp manufacturers who carry it is a regular item. There are many water works supply houses throughout the country who also stock this material in 50 and 25-lb. reels. The material is made up principally in three sizes. The ½-in. square is the standard size, which is designed to fit all diameters of bell and spigot pipe from 4 to 16 in., inclusive. The annular clearance in the bells is designed to be uniform for the same class of strength and weight pipe. The ⅜-in. square is furnished to meet the requirements when a spigot of fitting is entered into a pipe bell, the clearance being close. Likewise the ⅝-in. square is furnished to meet the requirements on reverse conditions.

Braided hemp for the water works field should be purchased of a good quality. The standard ½-in. size, free from any treating compound, should run about 16 ft. to the pound, the undersize, ⅜-in., 25 ft. to the pound, and the over size, ⅝-in., 10 ft. to the pound. The material should be of a reasonably long fiber hemp. Like a rope, the longer and better grade of the fiber, the better the hemp. It should be strong to withstand the punishment of the yarning tool when being forced into the bell and not shear in two or break allowing an opening for the molten jointing material to run through into

the inside of the pipe. This incident causes delay in the progress of the work. Besides it is an unpleasant thing to overcome. There is little difference in the cost of a short fiber hemp from a long fiber. Therefore, the longer fiber hemps are recommended.

In the use of square braided hemp the hemp is cut to length allowing a lap of about 2 in. for 4 and 6-in. pipe; 2½ in. for 8, 10 and 12 in.; and 3 in. for 16 and over. On account of the various makes of pipe, specific lengths to cut hemp would be numerous and difficult.

In application, a length of hemp is held on the extreme end of the spigot end of the pipe. The worker guides the spigot, holding it close to the top of the bell. At his word another man at the opposite end or leading bell end with a stick forces the entrance of the spigot into the bell, and the hemp rolls in on the bottom at the same instant. Be sure the pipe is "homed" well. Then with the yarning tool, without a hammer, push the hemp back to the bead or centering ring of the pipe on the bottom. This can be done easily, as the pipe is loose in the bell and care must be taken not to push the hemp over the bead or by the centering ring. Then with the assistance of a hammer, force the hemp in along both sides, and then on top letting the lapping end lead downward, that the molten material will not force an opening between the lap and on into the inside of the pipe. This completes the yarning. For lead, usually two raps around the pipe is taken, which leaves exactly 2 in. for the lead on standard pipe. For Leadite, but one strand is used, which leave 2½ in. depth for the Leadite.

This method of yarning does not require any special tools. No preliminary rolling or twisting is necessary. It does not require the skill of a mechanic to center it, pack it and space it for depths, as is required with the open jute. It will not burn through, as the material is very closely braided. A very nicely centered pipe is obtained, which is the success of any joint. A uniform depth is obtained for the jointing material, which effects a saving on the jointing material in that an exact amount of it is assured of being installed and little chance for an excess being used. As this method of yarning is very easily applied, greater speed is accomplished and there is very little chance of injury to occur. The pinching of the fingers, which often happens when centering up a pipe with wedges preparatory to installing open jute, is practically eliminated.

With Leadite as the jointing material, square braided hemp is highly recommended, because it is believed much better joints may be had, and, as only one-half the material is required compared with lead and open jute, it is without doubt more economical. Lastly, if a strand of open jute should be left extending outward into the bell and then the Leadite be poured into the joint, it would remain there forming a conductor for a water leak, which would require cutting out and repairing. The Leadite is not hot enough to burn up the open jute, as would be the case with molten lead.

In braided hemp there is practically no waste to the material. The hemp is cut to exact length. It is not used for a rag to clean mud from tools, the hands or shoes. It is not used to wipe out the bells or spigots of the pipe. It is not used for starting fires, nor is it used to wad up and place into the end of the pipe for over-night at the end of the day—and sometimes overlooked to be taken out the following morning. It will not drive over and into the pipe to float about and possibly clog up a service or stick up a meter, both of which are expensive maintenance charges. Lastly, if a piece of hemp is dropped along the ditch, it is recovered, which is never the case with open jute, as the latter gets full of dirt and the yarner will not use it.

Many waterworks superintendents and engineers feel that, over the older method of yarning with open jute, dry square braided hemp is well worth its additional first cost, and that very good economy is effected in its use.

Acknowledgment.—The foregoing is taken from the July Journal of the American Water Works Association. The matter was prepared for a subcommittee of the American Railway Engineers Association, on revising railway specifications for laying cast iron pipe. Data are based on practice in Indianapolis, Charleston, S. C., St. Louis, Fort Worth, and Independence.

Ohio Conference on Sewage Treatment

The third annual Ohio conference on Sewage Treatment will be held at Canton, O., on Tuesday and Wednesday, Oct. 22nd and 23rd. The headquarters of the conference will be at the Northern Hotel where the meetings will be held. Tuesday afternoon and Wednesday morning will be devoted to the presentation of papers and to discussions, with a dinner Tuesday evening. An inspection trip to the Canton and Salem sewage treatment plants will be made Wednesday afternoon. The Canton works comprise Imhoff tanks and trickling filters. The Salem plant is a new one of the activated sludge type and employs a number of the modern devices for sewage treatment. Salem is 32 miles east of Canton.

Papers are being prepared on the following subjects:

1. The Canton Sewage Treatment Works.
2. The Salem Sewage Treatment Works.
3. The Biological Oxygen Demand Test.
4. Operating Details of the Small Sewage Treatment Plant.
5. Sewage Disposal Litigation.
6. Discussion of the Sewer Rental Law.

The Ohio Water Purification Conference will be held at Columbus, Oct. 24th and 25th, with meetings at Fort Hayes Hotel. Those persons wishing to attend both conferences can drive to Columbus over good paved roads, a distance of about 130 miles.

Reservations at Canton should be made early at either Hotel Northern (conference headquarters), Hotel Courtland or Hotel McKinley. Reasonable rates can be secured at these hotels. For those planning to go to Columbus it is imperative that early reservations be made at Fort Hayes Hotel, there being two other conventions in Columbus at that time. In making reservations at either Hotel Northern at Canton or Fort Hayes Hotel at Columbus mention should be made of the Conference being held there.

On Saturday, Oct. 26th, Indiana plays Ohio State at Columbus. A block of seats has been reserved for those members of the two conferences wishing to attend the game. Application for tickets, accompanied by check (price $2.50 each), should be made to T. R. Lathrop, State Department of Health, Columbus, O.

A detailed program of the sewage conference will be issued later from the office of the State Department of Health. Floyd G. Browne is Secretary Ohio Conference on Sewage Treatment.

Market for Dried Activated Sludge.—The Sanitary District of Chicago has given considerable attention to the development of a market for dried activated sludge from its Des Plaines River sewage treatment works and its Calumet sewage treatment works, and in cooperation with the Milwaukee Sewage Commission the district has done a large amount of successful experimental and promotional work. According to the 1928 report of Edward J. Kelly, Chief Engineer of the Sanitary District of Chicago, the activated sludge has proved excellent for uses on golf courses, particularly on the greens, and in gardens. For 1928, the price has been set at $25 a ton, f. o. b. cars at Maywood, in small lots, and $22.50, f. o. b. cars, by the carload.

Sewerage in Wisconsin.—According to records of the Bureau of Sanitary Engineering of the State Board of Health, 211 municipalities in Wisconsin have public sewerage systems, 91 of which have provided disposal facilities through 106 sewage treatment plants. In addition there are listed 9 sewerage systems and 3 treatment plants of a semi-public nature. During 1928 plans for 34 new, modified or extended sewerage systems were approved by the bureau.

Water Works and Sewerage

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Encyclopedia Britannica's Fallacious Argument Against Water Metering

Speaking of the use of water meters the Encyclopedia Britannica says: "But the worst evil of the (meter) system, and one which must always prevent its introduction into the United Kingdom, is the circumstance that it treats water as an article of commerce, to be paid for according to the quantity taken."

This argument is perhaps the one oftenest used against the metering of domestic consumers of water. There is a subtle fallacy in it that has deceived, and continues to deceive, many a man. Since water is as necessary to life as is air, it is argued that it should be as nearly free as possible. Indeed, Britannica adds: "In the organization of the best municipal undertakings in the United Kingdom the free use of water is encouraged." Now the matter of fact is that there is no such thing as free city water, even in the case of the man who pays nothing directly for it, because he inevitably pays indirectly in the form of taxes. The water tax then becomes part of his monthly rent, and so is lost to his sight but not to the sight of his landlord. So the question resolves itself to this: "Is it preferable to pay for your water directly or indirectly?" Pay you must, in any event.

When payment is made directly and in proportion to use, men are apt to avoid waste. This is particularly true of water, electricity and gas. And, by the way, what is there about water that should cause it to be regarded differently from any other necessity that must be bought? Is it more necessary than food? As well might Britannica argue that food should be made free to the residents of a city as that water should be free. As well argue that the butcher should not weigh the meat and let the customer—and his dog—help himself ad libitum, as to argue that water should not be metered. Yet, deceived by the sophism of "Water Almost Free as Air," many a city (Chicago among the number) goes gingerly about the task of metering all its services. Why not make the sophism perfect by enlarging the slogan to read, "Food as Free as Air"?

There is a certain class of politicians who believe that it is popular to oppose universal water metering, yet where is the city that has ever adopted universal metering and afterward reverted to flat rates? The fact is that citizens are not such fools as some politicians imagine. Give them the facts about metering and their opposition soon wanes, if indeed such opposition has ever really existed on the part of the majority.

Reverting again to Encyclopedia Britannica's opposition to water metering, it should be remembered that in Great Britain there has developed a strong tendency to coddle the citizens, as contrasted with our American plan of encouraging each one to shift for himself. The British "dole" for the man out of a job is perhaps the latest evolution of that coddling policy. And what is the "dole" at bottom but an unmetered meal ticket? Just as "free water" encourages waste of water, so the "dole" encourages waste of time. To a pretty pass has this coddling policy brought that great empire. Seeing Americans marching steadily forward toward greater incomes, they attribute our progress mainly to natural resources. Well, if natural resources be the answer, they consist mainly in that part called resourcefulness—desire and ability to paddle one's own canoe.

Equivalent to a Semi-Monthly Municipal Magazine

Two of the *Gillette Construction Group* of magazines are so edited as to embrace the construction and maintenance features of municipal work, namely *Roads and Streets* and *Water Works and Sewerage.* For city engineers, superintendents, contractors and others engaged in municipal construction work, these two magazines are essentially one semi-monthly magazine, the one covering street work, street cleaning and traffic control, the other covering waterworks, sewers, and sewage treatment and disposal. The third magazine of the *Gillette Construction Group,* namely *Engineering and Contracting,* rounds out the picture for those who desire a complete view of progress in the civil engineering and contracting field.

City streets and country roads have been growing more and more alike ever since the advent of the automobile. It was perception of this fact that led us in 1916 to establish *Roads and Streets* (an offshoot from *Engineering and Contracting)* as a magazine useful alike to the city, county and state engineer engaged in highway design, construction and maintenance. As for the contractor in the highway field, the equipment

needed is the same inside as outside a city; and the methods of construction are usually identical. Indeed, were it not that those artificial boundaries known as "city limits," are often marked by signs, a motorist would usually not know when he had passed from the city street to the country road.

Roads and Streets is edited to serve those performing similar functions in the highway field, regardless of their titles. Snow cleaning, which was at one time confined to city streets, is a function that has spread to country roads. And the same is happening as to highway signalling and traffic control. Contrariwise, the cheaper forms of road surfacing (gravelling, etc.) that were formerly regarded as fit only for country roads, are being more and more used on residence streets until such time as the residents feel inclined to pay for permanent pavements. Indeed, there is no sound reason why any city or town street should ever be muddy, although many of them are no better than hog wallows in wet weather. In such cases the residents seem to think that until a permanent pavement can be afforded, they must go without any sort of surfacing. And so they wallow around for a decade, or a generation, waiting till they can afford a roadway, when they might, and should, have one somewhat short of perfection but at least smooth and solid. City engineers can often persuade residents in such cases to adopt some temporary type of surfacing that will eliminate all mud and dust; for, as to highways at least, a half loaf is far better than none.

The annual Road Show has become the mecca of city engineers as well as of county and state engineers, thus proving the community of interest of all who are engaged in highway work.

Water Works and Sewerage might be more briefly called Municipal Hydraulics, and that title was given consideration, but it seemed best to parallel the title of *Roads and Streets* by using two names that designate closely allied branches of the construction field. All consulting engineers, and nearly all city engineers, who specialize in water supply also specialize in sewage disposal. The same holds true of nearly all city contractors who engage in "ditch digging." So the wedding of these two names in the title of our magazine is merely the repetition of a wedding that has existed for generations between these two functions.

In America almost as much money is annually spent for new sewer as for new waterworks systems and betterments. And when the public has been fully convinced to the wisdom of not contaminating rivers, lakes and ocean beaches with sewage, the annual expenditures for sewerage systems will probably exceed those for waterworks.

A word in closing about *Engineering and Contracting*. We have recently added a section entitled "Nuggets of Knowledge on Methods and Costs," in which at least 50 short, nuggety articles are printed every month. This magazine aims to cover the engineering and contracting features of bridge and building construction, and of the miscellaneous structures of a civil engineering nature not covered by *Roads and Streets* or by *Water Works and Sewerage*.

The reader is referred to our advertising section for the subscription rates of these magazines when taken in combination.

The Twin Branches of Municipal Hydraulics

Without an exception consulting engineers who specialize in city waterworks specialize also in sewerage. These two departments of civil engineering are, and always have been, twin branches of one great tree —municipal hydraulics.

Water supply involves water disposal. A sewer is itself a water conduit differing hydraulically from a water supply pipe in that it does not carry water under pressure. But a sewer has the additional function of transporting refuse matter. It is perhaps the most economic conveyor of solids that man has designed, with the possible exception of the hydraulic monitor and sluice used in placer mining.

The primitive form of sewer, still to be seen in many European towns, is the gutter. Barely half a century has elapsed since our American towns began to equip themselves with sewer systems, but they have far outstripped the average European town in this respect. Our next great step will be to provide sewage treatment plants for practically all our towns, for we must not continue polluting our rivers.

The editor was much interested in seeing the ancient waterworks in Pompeii, which was destroyed by a Vesuvius eruption in 79 A. D. No sewer pipes were seen. The water pipes, which are small, are made of lead, and they look quite modern. Underground masonry aqueducts were the "supply mains." The public baths, with their devices for heating the water, are among the most interesting features of this ancient waterworks.

The early Romans solved many problems in hydraulics. Their aqueducts are remarkable engineering structures. Not less so are the massive arched sewers by which every street in Rome was drained into the Tiber. One of these sewers, 11x12 ft., is still in use.

More than 20 centuries ago men had devised and built remarkable water supply and water drainage systems in Rome; and even hundreds of years prior to that long aqueducts and reservoirs of large size had been built to supply many Mediterranean cities. The greatest handicap that the engineers of those early days had to contend with was the lack of iron or steel pipes for distribution of water and terra cotta pipes for removal of sewage. Lead was not only expensive but lacked strength. Bronze was even more expensive. They were driven to the extensive use of canals, long tunnels and masonry aqueducts. Magnificent as some of these structures were, the cost of their construction was enormous.

H. P. Gillette

48th Annual Convention of New England Water Works Association

The 48th annual convention of the New England Water Works Association, held Sept. 17 to 20 at Portland, Me., while not the largest from an attendance standpoint, was one of the most interesting and successful meetings of the association. The total registration was 570, made up of 228 members, 111 associate members and 231 guests.

The opening session on Sept. 17 was devoted principally to the reading of reports of committees. The officers of the association also submitted their reports. The secretary reported a total membership of 830, of which 701 are active members. The treasurer reported that the invested fund totaled some $15,000. The Dexter Brockett medal, which is given each year to the author of the best paper presented before the association, was presented to Francis W. Dean, engineer and architect, Boston, Mass., for his paper, "Pumping Station Practice." This paper was published in the June, 1928, Journal of New England Water Works Association. An interesting feature of the session was the election of Sir Alexander Houston, the famous engineer of the Metropolitan Water District of London, England, to honorary membership in the association.

The afternoon and evening sessions were devoted to the presentation of technical papers. One paper that aroused particular interest dealt with color reduction in storage reservoirs. This was presented by Caleb Mills Saville, Manager and Chief Engineer of the Board of Water Commissioners of Hartford, Conn. Another paper of much interest was "Beauty in Water Works Structure," presented by John C. Stevens, the architect who designed some of the buildings for the Portland Water District. The other two papers dealt with the Portland Water District.

At the morning session on Wednesday two papers were presented. In one of these Percy Sanders, Superintendent of Water Works, Concord, N. H., described that city's experience with automatic chlorination. An abstract of this paper will be found elsewhere in this issue. The other paper, presented by Ralph S. Bauer, Mayor of Lynn, Mass., dealt with the financial administration of a water works. The afternoon was given up to a clam bake and sail on Casco Bay. The water works superintendents' meeting comprised the evening session. At this session the reports of the legislative committee and the committee on painting standpipes were presented. Three papers also were presented: "Test of Large Meters in the Field," by R. E. Ferguson, Assistant Superintendent Hersey Mfg. Co.; "Experiences with Diesel Engines in Water Works Plants," by A. D. Couch, Mechanical Engineer, Community Water Service, and "Diesel Pumping Units at Wayland and Wilmington, Mass. Mr. Ferguson's paper is abstracted in this issue.

At the Thursday session the following papers were presented:

"Method of Testing Cast Iron Pipe," by Wm. R. Conrad (abstracted elsewhere in this issue); "Some Uses of Aeration in Water Purification," by Malcolm Pirnie; a description of the water works improvements at Springfield, Mass., by E. E. Lochridge; "The Reconstruction of the Pumping Station of the Western New York Water Co.," by H. W. Huy; "Making of Water Works and Pressure Studies," by Herbert E. Smith.

At the morning session on Friday, Arthur E. Gorman presented a paper, "Watching the Weather in Safeguarding Public Water Supplies," and J. Frederick Jackson presented a paper entitled, "Enforcement with Other Beverages," which dealt with the control of bathing in public water supplies.

The entertainment features were as follows: Sept. 17, 1 P. M.—Maine clam chowder luncheon at new shops of Portland Water District, followed by inspection of shops and standpipe painting inspection. (Courtesy of Portland Water District.) 8 P. M.—Informal reception for ladies at Hotel Eastland. 8:15 P. M.—Theatre party for ladies. (Courtesy of Geo. F. West & Son.)

Sept. 18, 11:30 A. M.—Clam bake and sail, Casco Bay. (Courtesy of Water Works Manufacturers' Association, Inc.) 8 P. M.—Ladies' reception and bridge at Hotel Eastland. (Courtesy of Water Works Manufacturers' Association, Inc.) Sept. 19, 10 A. M.—Sightseeing trip for the ladies. (Courtesy of Portland Chamber of Commerce.) Followed by coffee at Portland Chamber of Commerce. 7:30 P. M.—Dinner dance and entertainment at Hotel Eastland. (Courtesy of Water Works Manufacturers' Association, Inc.) Golf tournament.

The officers elected for the ensuing year were as follows: Robert Spurr Weston, consulting engineer, Boston, president; George H. Finneran, superintendent water service, Boston, first vice-president; George C. Brehm, city engineer and director of public works, Waltham, Mass., second vice-president. The following continue in office: Frank J. Gifford, Dedham, Mass., secretary; Albert L. Sawyer, Haverhill, Mass., treasurer; Prof. Gordon M. Fair, Cambridge, Mass., editor.

Flume for Testing Models of Hydraulic Structure

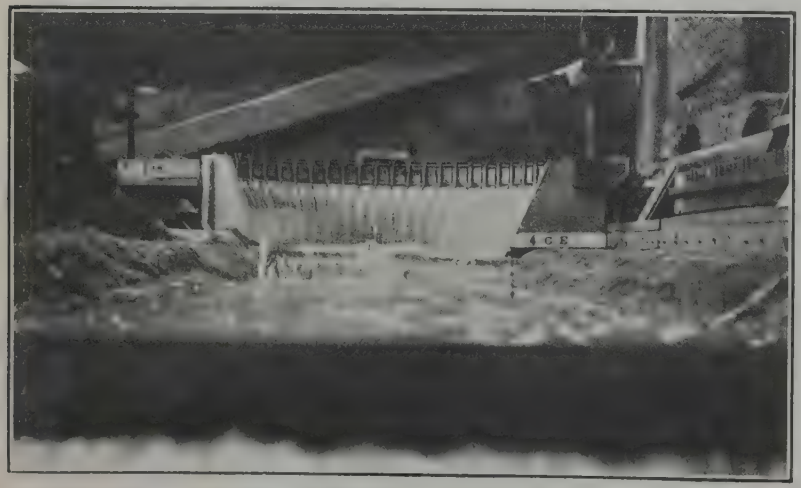
A flume for testing models of dams and other hydraulic structures has been recently installed in the new laboratories of the Carnegie Institute of Technology and experiments on a model of a commercial dam have already been made.

This flume is 72 ft. long, 13 ft. wide, and 3½ ft. deep, and is equipped with a centrifugal pump with a capacity of 3,000 gal. per minute. According to Professor Harold A. Thomas, associate professor in charge of the hydraulic department at Tech, it is probably one of the most suitable flumes in the country for testing hydraulic structures.

The flume is located in the new addition between the north wings of Engineering Hall. To the north of it is the materials testing laboratory, with its new equipment. The materials laboratory was moved from Machinery Hall to provide space for the new aeronautics laboratory.

Both undergraduate and research study will be made on models in this flume. Spillways, outlets, cushion pools and other hydraulic equipment will be tested. Model dams can be constructed and easily fitted into place and the stream of water controlled to reproduce the flow of a river on which the dam will be built according to the laws of similitude.

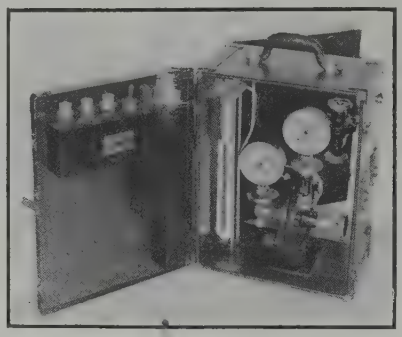
During the summer months commercial engineers have been cooperating with Professor Thomas on the model of a dam now being built in the south. The model, built on a scale ratio of 1 to 100, was constructed by Mr. William Pfouts, head instructor of patternmaking at Carnegie Tech. Every detail of the prototype was reproduced in the model. Even the topography of the river bottom was carefully reproduced with concrete. Professor Thomas states that other models will be tested in the near future.



Test Being Made on Model Dam at Hydraulic Laboratory, Carnegie Institute of Technology

A New Portable Chlorinator

The Paradon Mfg. Co. of Arlington, N. J., have recently developed an unique new portable chlorinator. The apparatus is housed in a tough fibre case,



New Paradon Portable Chlorinator.

constructed similar to a piece of hand luggage. When closed, it looks exactly like a piece of baggage, and will readily pass as such, making its transportation easy.

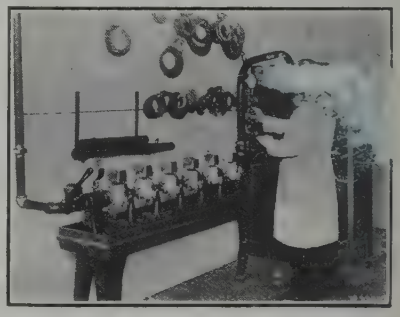
A complete standard dry feed Paradon chlorinator is used, fully equipped to the last detail. The unit is adaptable to continuous regular chlorinating service as well as occasional emergency use. A silver chlorine shut-off valve is provided, making it possible to keep the apparatus under chlorine pressure when not in use, thus preventing access of moisture and other foreign material, and allowing long periods of disuse with attendant deterioration of the unit.

No water supply is necessary for its operation. The apparatus can be supplied for any range of capacity from 1 lb. of chlorine per 24 hours to 300 lb. per 24 hours. Equipment can also be supplied that will decrease the minimum capacity to .03 lb. of chlorine per 24 hours. A chlorine testing outfit, spare parts, connection to main, and all other necessary accessories are contained in the carrying case of the apparatus. A similar fibre carrier is provided for two small cylinders of chlorine (12 lb. capacity each), and which can also be used in conjunction with the portable chlorinator.

The uses of the Paradon portable chlorinator are many, as, for sterilizing mains before putting into use, for eliminating after pollution in dead ends of mains, etc., for algae control, as a steady unit for regular chlorination, for the chlorination of emergency supplies due to broken mains, low water, etc., for the chlorination of water supplies used in connection with construction work on water sheds, for prechlorination, double chlorination, etc., also in sewage work for fly control, biological oxygen demand control, odor control; in fact, the portable chlorinator may be used to control the application of chlorine for any use that chlorine can be put to.

Testing Six Meters at One Time

The city of Bloomington, Ill., keeps close check on the revenue of its water department by regular testing of water



Meter Testing at Bloomington, Ill.

meters. The illustration shows the testing of six meters at one time with the Clark No. 622 meter tester, "weighing type." This multiple tester is stated to have effected very great savings in the testing costs of the department as well as insured accuracy of the meters —which has resulted in almost entirely eliminating complaints from consumers regarding charges.

Sewer Systems in Iowa.—Of the 920 cities and incorporated towns in Iowa, 319 have sewer systems. These systems serve 1,183,000 people, or 84.5 per cent of the total urban population. Of the 93 second class cities with populations ranging from 2,000 to 15,000 only one has no sewer system. Of the 96 incorporated towns with populations between 1,000 and 2,000, 85 have sewer systems. Of the smaller towns ranging from 500 to 1,000 in population nearly 50 per cent have sewer systems.

Water Works and Sewerage

Vol. LXXVI NOVEMBER, 1929 No. 11

Revolving Sprinkler and Dosing Chamber, Sewage Treatment Plant, Pontiac, Mich.

ow to Keep Sewage Filters in Operating Order

Successful Operation of Filters Can Be Secured Through a Complete Understanding of the Functions of the Filter and a Clear Knowledge of the Filter and Its Component Parts

By C. H. CURRIE

Currie Engineering Co., Webster City, Ia.

THE American Society of Civil Engineers and the American Public Health Association a few years ago adopted definitions of terms used in sewage treatment and define the two types of sewage filters as follows:

Intermittent Filter: A natural or artificial bed of sand or other fine grained material to which sewage is intermittently applied in doses and through which it flows, opportunity being given for filtration and also oxidation of the organic matter by bio-chemical agencies.

Trickling Filter: An artificial bed of coarse material, such as broken stone, clinkers, slate, slats, or brush, over which sewage is distributed and applied in drops, films, or spray, from troughs or drippers, moving distributors, or fixed nozzles, and through which it trickles to the underdrains, giving opportunity for organic matter to be oxidized by bio-chemical agencies.

The main purpose of each filter is the oxidization of the organic matter in the sewage, and the filters should be so constructed as to furinsh the best conditions obtainable for the bio-chemical agencies to perform their functions and to thrive.

Aerobic bacteria, upon which this oxidation depends and which is supplied by nature, require a home, which, in this case, is the surface of the sand or stone particles, and food, which is the organic matter in the sewage.

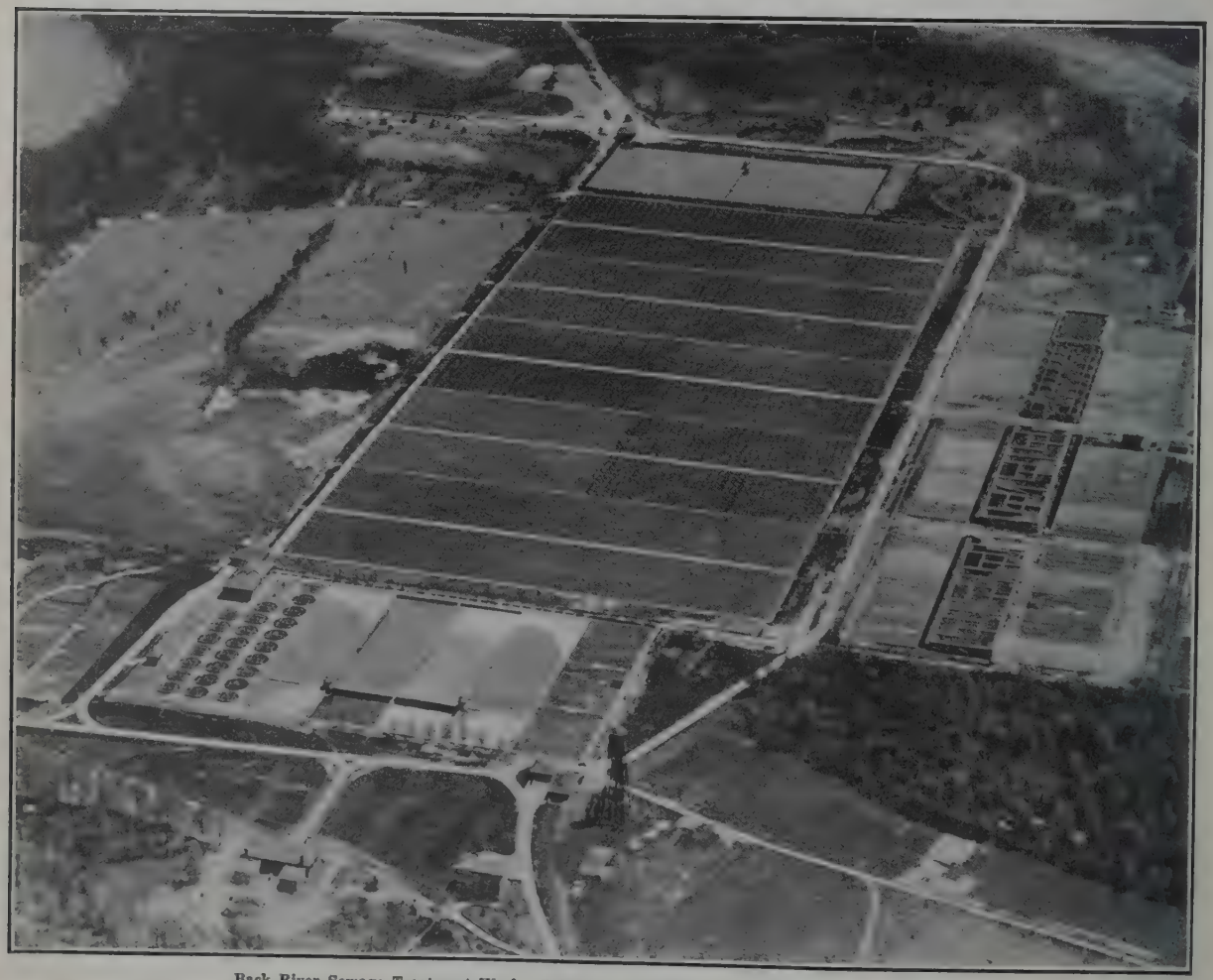
Many years of experience throughout the world have practically determined the various dimensions and capacities of both types of filter beds for various conditions, together with the most effective sizes of materials to be used in them. Granting that either type of filter bed is properly designed for the purpose intended, an equally important factor in results is the proper care in operation of these beds. No filter bed will function properly and efficiently unless it is properly cared for at all times, and the best of filters will soon be failures if neglected.

Intermittent Filter.—The artificial intermittent filter is constructed with underdrains rather close together, with a dirt ridge between each row of underdrains. The underdrain tile are covered with small gravel, the main purpose of which is to prevent the sand from washing into the underdrains. Over this gravel is spread from 18 to 24 in. of clean graded sand. The sizes of these sand grains and the cleanness of the sand are vital factors and most state boards of health specify cleanness, effective size, and uniformity coefficient permissible in this sand filter. A generally recognized dose of sewage, amounting to a 3-in. depth of liquid over the surface of the sand, is usually

designed for. This dose is conveyed onto the intermittent filters through surface pipes or troughs, carrying the liquid to all parts of the sand surface. It is important that the surface of the sand beds should be level and that the places where the liquid first strikes the sand surface should be protected from erosion by gravel or other material. After this dose occurs on any bed, it is advisable to give this bed a rest period of several hours to permit the sewage to seep on through the sand bed and provide a sufficient interval of time for the proper increase of the bacteria, which have been greatly depleted in their work of stablizing the sewage which has passed through it. It is obvious that the clogging of the surface of the sand will prevent this ideal condition; hence, the most vital operating need of the intermittent sand bed is a clean surface. No vegetation should be permitted to grow upon this sand surface and as the strainings of the solids carried over from dosage tanks are trapped in the upper thin film of sand, it is also necessary to keep this film well removed.

A small amount of work spent frequently on a sand bed is much more important than a great deal of work at infrequent intervals. In winter, it is necessary to provide ridges or piles of material at short intervals upon the sand surface, which will support a thin ice covering and permit the liquid to flow underneath this ice film during extremely cold weather. Some plant operators still build these ridges by furrowing the surface of the beds; others start in the early fall and rake up a thin amount of the upper surface with the solids attached in cone-shaped heaps, about 6 ft. apart. This latter practice would seem to be better, inasmuch as the level surface is not disturbed and when the winter is over, these heaps are easily removed without mixing any of the dirt deeper into the sand. With the furrowing system, it is necessary and important to carefully scrape all the upper dirt from the furrow before the sand is re-leveled, and even then, there is a grave danger of mixing the dirt into the upper few inches of the sand bed, which eventually will cause clogging and will necessitate the removal of this depth of dirty sand. If the operator has clearly in mind the need of maintaining a clean bed of sand at all times and never disturbs the surface below a very shallow depth, he should experience no serious difficulty in securing excellent operation. In the course of a year, some amount of the sand bed is necessarily removed from the surface and when this amounts to as much as from 4 to 6 in., the upper surface should be scraped clean and additional proper sand added.

Properly operated, the sand filter bed is probably the most efficient means of sewage purification today, although the operating cost may be somewhat higher than that of the stone beds. Neglect or other factors may cause a sand bed to become so clogged throughout its depth that renewal of the sand becomes necessary. If such a condition exists, a study should be made as to the relative economy between removing and washing the sand as against the removal of the sand and replacing the same with new sand. The tile underdrains may fail and the operator should dig down and investigate the underdrains, should they appear to be



Back River Sewage Treatment Works, Baltimore, Md., Showing Trickling Filters in Center

sluggish, and replace defective tile where needed.

The practice of some operators in by-passing their sand filters during cold weather is an admission of lack of intelligent operating ability on their part. Freezing of underdrain tile may cause many of the tile to disintegrate.

While sand filters may not perform as efficiently in cold weather as in warm, ice-covered outlet streams demand the best purification possible, if fish life is to survive.

All openings in surface distributors should be so adjusted that a uniform amount of sewage flows from each one.

Trickling Filter.—Inasmuch as the total surface area required for trickling filters is not over one-tenth that of the intermittent filter, the floor or bottom of the stone bed is generally constructed of concrete, as well as the side walls, and the expense of a superstructure over the entire bed is often justified. The underdrain tile, quite closely spaced, should drain into a common outlet and have a gallery at each end for inspection and cleanout purposes. Over these underdrains are usually placed 6 ft. or more of hard stone, generally varying from 1 to 3 in. in size, although some filters have smaller stone and others somewhat larger. The sewage is distributed over this stone bed in such a manner as to secure an even amount of liquid over every square foot of surface, if possible. The general custom in America is to accomplish this by means of spray nozzles from dosing or equalizing tanks on the lines of distribution to insure a varying head which tends to secure an even distribution over the surface. Because of the coarser material used and because of the rapidity with which the bed can empty itself of a dose, the rest period as needed in the intermittent filter, is not required with the trickling filter, and many authorities now consider that a very short cycle between doses, even as low as five minutes, may be highly desirable. The important thing in the operation of a properly designed and constructed filter is: First, keep the nozzles clean so the sewage may be distributed evenly over the entire surface. Matches, cloth, and other material may get through the clarifiers and catch in the nozzles or distributors. In keeping these clean, the operator should be careful in handling his particular distributor so as not to damage the mechanism of distribution. Screw and "key" nozzles are easily bent in removing and may seriously interfere with the distribution intended. Occasional removal of the nozzles at the ends of the distribution lines for a short flushing period may be advisable in some instances. Second, watch for ponding on the surface of the bed and stop this ponding as soon as it appears. Third, see that underdrains are clean.

There are various ways in which ponding may be relieved, some of which should be successful with any individual plant. Some operators find the use of a hose in washing down the surface stone breaks up the ponding. Others find that stirring of the upper surface of the stone stops this. Still others find that resting of the bed from dosage for a one-day period often relieves this situation; still others find that the use of chlorine in the dosing chamber for a short period of time will clear up the surface of the beds from ponding. Each operator can determine for himself the needs of his particular stone bed upon trial, and should, of course, use the easiest and most inexpensive method first until he has determined the one best suited to his particular bed.

The underdrains should be accessible for observation and cleaning, and if any of them show evidence of clogging, they should be kept clean at all times. The uniformity of underdrain flow in the underdrains may indicate the uniformity of distribution over the surface of the bed.

The writer's observation over a period of many years convinces him that those sewage plants operated or cared for by men who have a mental picture of the construction of their plant, together with an understanding of the functions of the various units of his plant, are generally the plants which produce satisfactory results, and the poorly operated plants (which are many) are generally operated by men who do not thoroughly understand what they are to do or why they are to do it.

It is to be hoped that the day is not far distant when the vital importance of intelligent sewage plant operation will be recognized by the people and laws passed to secure this much needed condition, or existing laws properly enforced.

Acknowledgment.—The above is a paper presented Oct. 23 at the 11th Iowa Sewage Treatment Conference at Iowa State College, Ames, Ia.

Advantages to Householder of Water Softening

An interesting outline of the advantages of softened water to the average householder was given in Vol. 93, 1929 Transactions of the American Society of Civil Engineers, by C. W. Foulk, Professor of Analytical Chemistry, Ohio State University, Columbus, O. He stated that the Columbus plant removes from 180 to 190 parts per million of hardness from the Scioto River water. This, if left in the water, would destroy about $6 worth of soap per year in the average household. (The household price of soap is taken at 10 ct. per pound.) On the basis of 50,000 households in Columbus, $300,000 worth of soap would be wasted each year. This waste is eliminated by the softened water.

Considering the positive gains arising from the use of soft water, attention is called to the following items in the construction and operation of a house, which are needed in a hard-water city, but not in one with a soft-water supply:

100 bbl. cistern	$110
Electric water pump	120
Installing pump	20
Extra plumbing	50
Total	$300

This means that it costs $300 less to build a house in Columbus than to build the same house under the same conditions in a hard-water city. If interest and depreciation are calculated, it is seen that there is an annual saving of from $25 to $30, because of the soft-water supply.

Long Sewer Outfalls in California

In the earlier outfalls in Southern California, the length from shore was set arbitrarily, even in the case of large outfall sewers, such as that for Los Angeles. The lengths of the more recent outfall sewers have been gauged from the behavior of B. Coli fields of pollution determined from pre-existing outfalls. The outlets are generally made to discharge from upturned ells lying on the ocean floor, in order to avoid their becoming clogged with shifting sand, and to prevent the transmission of water hammer. In a discussion in the September, 1929, Proceedings of the American Society of Civil Engineers, R. F. Goudey, Resident Engineer at Los Angeles of the California State Department of Public Health, gives the following examples of long outfalls in California that have a vertical discharge:

Long Outfalls with Vertical Discharge

City	Population, present	Treatment	Diameter, in inches	Outfall Length, in feet	Depth, in feet
Los Angeles	1,250,000	Screening	84	5,400	63
Orange County	60,000	Screening	42	2,700	40
Santa Monica*	50,000	Screens	24	2,000	25
Santa Barbara	40,000	Screening	42	3,694	40
Ventura	20,000	Screening	17	2,000	30
Venice	20,000	Screening	14	1,360	25
Santa Cruz	16,000	Screening	2-15	2,000	37
Watsonville	10,000	Screening	16	1,500	20
Oceanside	5,000	Septic tank	11	2,000	33
Mission Beach	5,000	Septic tank	14	1,200	22
Pismo	3,000	Septic tank	11	1,700	17
Pacific Beach	3,000	Septic tank	14	1,500	15
Laguna Beach	2,000	Septic tank	10	600	15

*Downward discharge.

The Consumption of Water and the Effects of Metering

Maximum and Minimum Per Capita Consumption for Various Purposes—Comparative Growth of Metering—Effect of Meters on Water Consumption—Reduction in Consumption Due to Metering

By LYMAN M. VAN DER PYL
Chief Chemist, Pittsburgh Equitable Meter Co.

THE path followed in the study of water supply systems extends far back to antiquity, and it is indeed a fascinating story to follow through the ages. Ancient wells are still furnishing water in Egypt and India; some of the water tanks at Aden in Arabia, built probably more than 2,000 years ago are still used in supplying the modern city with water. Athens, Carthage and Loadicea and other ancient cities had their collecting and distributing systems, but undoubtedly the most famous system was that of Rome which is said to have supplied according to various estimates, from 50 to 400 gal. per capita daily around 100 A. D.

From those figures to that of Paris in 1550—1 quart per capita per day—is a far cry, and the difference probably explains why the ravages of pestilence were so widespread in mediaeval days. Even in 1700 Paris was supplying only 2½ quarts of water per capita per day. Since then, with the development of modern collecting and distributing systems the increase in water consumption has helped immensely in raising the standard of living and in making possible the growth of our large cities. At the present time in the United States there are more thas 9,000 communities with water supplies and the domestic consumption ranges from 15 to 75 gal. per capita daily.

The amount of water consumed involves a statistical study of great importance to the water works man in planning future changes and enlargements, and it is the purpose of this article to give briefly an account of the influences that have bearing on the quantity of water that must be supplied to satisfy the demand.

The actual consumption of water is determined in a number of different ways. One common method is to compute it from the number of strokes of the pumps, knowing the piston displacement and applying a correction factor for pump slip. Weirs are sometimes used, especially in the case of gravity systems, but probably the best results are obtained by using some sort of a meter. Irrespective of the manner of obtaining the figure, however, this total consumption includes all the water sent into the mains, including waste and leakage as well as water actually used.

The study of water consumption naturally begins with the division of the supply according to the major purposes for which it is used. Such a classification is of course, useful in laying out different parts of a distribution system, as for instance when an extension is to be made in a manufacturing or in a residential district. For this analysis it is customary to divide the total supplies into five classes, as shown in Table I (Jour. Am. W. W. Assoc. [1915] 181) where the consumption is divided according to the actual figures of a number of cities of different sizes.

In the table are listed only cities in which the consumption of water is wholly metered or very nearly so, as obviously any other method of obtaining consumptions would result in nothing more than estimates. As may be seen there are wide divergences between the various cities in the amounts of water used by the various cities and a discussion of the various factors responsible for these differences is in order.

Table II—Maximum and Minimum Per Capita Consumption of Water

Use	Gallons Per Capita Daily Minimum	Maximum	Average
Domestic	20	50	35
Commercial and industrial	10	50	30
Public	5	15	10
Loss	15	40	25
Total	50	155	100

COMPARATIVE GROWTH OF METERING IN SEVENTEEN CITIES

City	Year	Number Meters	Year	Number Meters	Year	Number Meters
Fall River	1900	6,544	1905	7,523	1928	13,000
Woonsocket	1905	2,366			1927	5,350
Lawrence	1904	5,744			1928	10,500
Hartford	1904	9,860	1919	15,451	1929	19,000
Kansas City	1905	11,344			1929	71,000
Yonkers	1905	6,207			1929	14,600
Lowell	1905	7,889			1928	14,500
Brocton	1905	5,851			1929	10,800
Chicago	1890	3,924	1919	26,000	1929	65,000
Cleveland	1904	30,226			1928	65,000
Syracuse	1904	11,059	1919	28,133	1929	36,000
Covington	1904	5,441			1928	12,600
Springfield	1904	3,957	1919	14,600	1929	21,000
Fetchburg	1905	5,068			1927	56,000
Madison	1903	3,336			1928	9,400
Taunton	1904	2,199			1927	6,000
Rochester	1905	14,065			1929	58,500

Table I—Consumption Per Capita for Various Purposes

City	Population	Per Cent Taps Metered	Consumption in Gallons Per Capita Per Day: Domestic	Industrial	Commercial	Public	Loss	Total
Milwaukee, Wis.	430,000	99.4	33.0*	430	.....	5.8	29.2	111.4
New Orleans, La.	360,000	99.7	16.8		12.8	3.2	24.4	57.2
Rochester, N. Y.	250,000	99.5	31.3	18.3	12.2	4.8	28.4	95.0
Fall River, Mass.	115,400	97.8	18.0*	6.8	.....	14.2	7.2	46.2
San Diego, Cal.	85,000	100.0	36.0	7.2	12.0	10.0	15.4	80.6
Wilkinsburg, Pa.	80,000	99.0	25.4		59.6	2.4	12.6	107.0
Lexington, Ky.	40,000	100.0	16.9	17.9	16.0	8.4	2.9	62.1
Oak Park, Ill.	26,000	100.0	52.5	8.5	1.6	2.5	3.9	69.0
Elyria, Ohio	16,000	100.0	38.8	47.0	7.2	5.6	22.5	121.1

*Includes commercial use.

Domestic Consumption. — The domestic consumption of course, depends largely on the personal habits of the people of the community, and to a considerable extent the water used is an indication of the standard of living. The following figures, averaged from the statistics of 14 cities present the domestic use in different types of dwellings (Jour. N. E. W. W. Assoc. 27, [1913] 55):

	Gal. per capita per day
Apartment houses	62
First class dwellings	54
Middle class dwellings	34
Lowest class dwellings	15

It is worth noting in this connection that the amount of water used is increasing, even in metered communities.

A decidedly variable item in the domestic consumption figure is the water used for sprinkling lawns and gardens; in dry localities, of course, more water is used in this way than in places where

Table III—Effect of Meters on Water Consumption

Per Cent of Services Metered	CITIES 5,000 TO 25,000 POPULATION		CITIES 25,000 TO 100,000 POPULATION		CITIES 100,000 POPULATION AND OVER	
	Number of Cities	Gallons per Capita per Day	Number of Cities	Gallons per Capita per Day	Number of Cities	Gallons per Capita per Day
0–10	60	161	16	198	3	218
10–20	20	199	3	144	3	149
20–30	17	128	2	208	3	154
30–40	15	108	4	116	3	170
40–50	8	88	5	105	3	160
50–60	18	141	5	165	0	0
60–70	18	120	4	91	0	0
70–80	16	140	10	84	4	97
80–90	31	79	9	107	10	127
90–100	145	91	53	94	22	97
Total	348	.....	111	.....	51	

Table IV—Effect of Meters on Water Consumption

Group	Number of Cities	Population Per Group	DAILY CONSUMPTION			Number of Services	Number of Meters	Per Cent Metered
			Total Millions	Gallons per Capita				
				Range	Average			
1	4	379,198	18.60	45–55	49	43,502	41,109	94
2	8	1,307,341	85.88	56–70	66	193,057	173,410	89
3	8	926,252	71.23	71–80	77	149,781	122,165	81
4	13	1,096,729	97.03	81–95	88	170,882	128,571	75
5	7	1,083,068	112.33	96–110	104	180,039	125,271	69
6	7	1,408,465	159.74	111–120	113	238,291	144,497	60
7	8	1,588,716	203.72	121–130	128	271,327	64,266	24
8	9	1,491,518	206.49	131–150	138	291,517	55,450	19
9	4	1,993,951	351.66	181–200	176	432,583	76,100	17
Total	68	11,275,238	1,306.68	45–200	110	1,970,979	930,839	47

the rainfall is heavier. For sprinkling lawns 7 to 8 gal. of water are required per 100 sq. ft. of surface and inasmuch as lawn sprinklers and garden hose nozzles will pass from 225 to 660 gal. of water per home (Jour. N. E. W. W. Assoc. 28 [1914] 377), the amount of water used in this manner will be considerable; in Denver, 10 per cent of the total supply is said to be used in this way.

High distribution pressures have a very direct bearing on domestic consumption. Hartford, Conn., for instance, saved 300,000 gal. daily or approximately 4 per cent of its total demand by throttling its valves. (Eng. Rec. Feb. 5, 1916, p. 184.) The introduction of sewers will increase the use of water in some instances as much as 100 per cent; incidentally it has recently been suggested that the cost of extensions to sewer systems be apportioned among the properties using them according to their respective water consumptions as determined by meter readings.

Industrial Consumption.—Industrial requirements for water vary with the nature of the industries served; tanneries, laundries, chemical works, and paper mills are large consumers, while water for steam generation is a considerable item in most industrial demands. In some localities industries draw their own water from rivers or from their own wells and there is practically no industrial demand, while in some cities the industrial load is more than half the total water consumed. Commercial users of water embrace not only stores and hotels but also rooming and apartment houses.

Water for public uses is generally furnished free and unmetered though often the amount of water so used is considerable—13.6 per cent of the total consumption in San Diego, Cal., and in Lexington, Ky., in 1914 (Proc. Am. W. W. Assoc. [1915] 191-195). It includes water for schools, public buildings, parks, street sprinkling, road construction and fire fighting.

The last item, "loss," is sometimes called "unaccounted for" or perhaps more aptly "waste." It covers leakage from mains and fixtures, under-registration of meters and careless or wasteful use for purposes legitimate in themselves. Metering will minimize the last named waste and any persisting waste will be metered and paid for. In a meter system, the total loss should not be greater than 20 per cent of the whole consumption; the loss then would be largely due to leakage from mains and careful inspection will keep this at a low figure.

As averages of the above figures, Turneaure and Russell (Public Water Supplies p. 22) give the figures shown in Table II, applying to supplies having good metering systems.

Minimum or maximum sizes for all purposes are not likely to occur at the same time, so that the totals of minima or maxima are extreme figures. Probably a normal minimum could be 60 gal. per capita daily while a normal maximum would be close to 125 gal.

In unmetered system the normal total consumption would not be far from 150 gal. per capita daily as against an average 100 gal. per capita in metered systems. Under especially favorable conditions, the consumption in the unmetered system might use as high as 300 gal. per capita daily; for example, Chicago in 1921 was using 276 gal. per capita daily while Coeur d'Alene, Idaho, used 316. (Flinn, Weston and Bogert, Waterworks, Handbook, p. 578.)

Variations in Consumption.—The figures given above show the average daily demands over a long period of time, but there are variations, sometimes of considerable magnitude, existing over short periods. Of course, all parts of the supply and distribution systems must be made large enough to supply the greatest demand that will be imposed on them and it is consequently necessary to study these variations.

The usually accepted figures are that the maximum monthly rate will be 125 per cent of the average, while the maximum daily rate will be 150 per cent of the average; for smaller cities, however, the maximum daily rate is likely to be over 200 per cent of the average rate. Further, the maximum hour will draw water at 150 per cent of the rate of the maximum day. Consequently the system should be capable of delivering 150 per cent of 150 per cent, or 225 per cent, of the average consumption. If the system is also to be used for supplying water for fire fighting, it should be capable of handling in addition 150 to 200 per cent of the average. In large cities, incidentally, the fire consumption should be about 50 per cent of the average, while in very small towns it may be as high as ten times the average rate.

REDUCTION IN CONSUMPTION DUE TO METERING IN CITIES THAT HAVE ADOPTED A UNIVERSAL METERING PROGRAM

City	Universal Metering Adopted Date	Per Cent of Services Metered				Per Capita Consumption				Population Time of Adoption	Estimated Population July 1, 1925	Per Cent Increase	Maximum Rate Per 1,000 Gallons Cents
		5 Years Previous	Time of Adoption	5 Years After	1925	5 Years Previous	Time of Adoption	5 Years After	1925				
Detroit	1913	10.0	23.6	97.4	99.07	162.0	163.0	144.0	130.0	624,139	1,257,634	101.0	8.7
Cleveland	1901	4.5	68.0	100.0	100.0	168.3	130.7	96.1	127.4	399,558	812,502	125.0	8.0
Los Angeles	1905	0.0	19.1	58.4	99.0	300.0	175.0	141.0	119.0	210,838	705,411	234.0	9.7
Milwaukee	1899	61.0	83.0	95.0	99.0	101.0	83.0	86.0	128.0	277,231	492,087	77.0	9.3
Newark	1915	45.0	60.6	92.2	95.5	107.0	110.0	108.2	100.2	380,996	445,806	14.0	19.2
Minneapolis	1905	25.1	45.7	79.6	100.0	92.7	66.5	73.8	107.8	252,063	415,280	65.0	8.0
Cincinnati	1915	32.8	64.9	98.2	98.6	127.8	125.9	123.4	116.1	382,419	407,835	6.5	16.0
Kansas C'y, Mo.	1905	29.0	38.0	44.4	82.5	60.7	93.8	98.0	125.7	296,066	359,650	74.0	22.7
Rochester	1905	28.6	41.0	97.0	99.0	76.2	78.9	80.8	98.0	190,378	325,211	71.0	16.0
Columbus	1905	32.0	76.2	91.31	99.1	150.0	59.6	75.6	92.8	183,530	266,709	74.0	16.0
Oakland	1910	48.6	57.2	100.0	100.0	90.9	85.6	54.3	64.1	150,174	246,898	64.0	27.9
St. Paul	1912	51.1	84.8	97.3	92.5	60.7	60.9	81.2	71.5	218,734	243,946	12.0	12.0
Akron	1912	25.0	45.0	100.0	100.0	106.3	117.2	93.2	87.0	96,941	278,119	187.0	21.4
Av. of 13 Cities since	1901	30.1	54.39	87.5	97.8	123.4	103.8	96.5	104.8	3,543,167	6,358,883	79.0	15.0

METERS MANUFACTURED 1910-25
(five manufacturers)

Year	No. Meters	Year	No. Meters
1910	295,000	1918	340,000
1911	310,000	1919	330,000
1912	340,000	1920	410,000
1913	325,000	1921	390,000
1914	365,000	1922	490,000
1915	375,000	1923	560,000
1916	410,000	1924	575,000
1917	385,000	1925	640,000

Finally, in making provision for future demands on the water supply system, the future increase in population must be estimated; this is done by interpolating past rates of growth of the city and by comparing with the growth of other cities of similar size

making allowances, of course, for the different characteristics of the two cities. Cognizance should be taken as well of the fact already noted, that the average rate of legitimate water consumption is increasing. As systems become more nearly completely metered, however, the rate of decrease of illegitimate consumption will more than compensate for the rate of legitimate increase until the rate of meter installation drops down.

Despite the prejudice against water meters in certain sections and notwithstanding the objections to their installation raised as political expedients it is worth noting that of the municipalities that have adopted them not one has ever gone back to the old system. (Eng. News Record, Feb. 7, 1918, p. 269.)

Reduced Waste with Meters.—Countless numbers of cases where water meters have reduced the waste of water may be cited, and in every case the reduction is very marked. Table III from the report of the Engineering Board of Review to the Board of Water Commissioners of Denver shows clearly that water consumption decreases as the percentage of services metered increases. Another tabulation by Hill (Eng. News-Rec. 79, 1917, 312) groups 68 cities with a total population of more than 11,000,000 according to their per capita consumption, as shown in Table IV; as may be seen the percentage of meters to total services falls rapidly as the consumption rises. As a specific instance the case of Boston shows a rapid decrease in the rate of consumption as the number of meters increases.

With such practical unanimity of opinion as exists on the value of metering and with a realization of the axiomatic equity of the system of paying for water actually received, it is difficult to class those approving the installation of meters as anything except proponents of an antiquated and unfair method of taxation. Just as the gas industry was forced for its own protection to turn from flat rates to meters, so will the water supply industry, both public and privately owned, turn eventually and completely to meters, and that far before the millenium is reached.

Acknowledgment.—The foregoing is reprinted from October Water and Light, the journal of the southeastern section of the American Water Works Association.

Cost of Pumpage at Dubuque, Ia.—The following taken from the 29th annual report of the Water Department of Dubuque, Ia., shows the average cost of pumpage for the year ending March 31, 1929:

	Per 1,000 Gal.
Operating and maintenance only	$0.0662
Operating, maintenance and depreciation	.0914
Operating, maintenance and interest	.0770
Operating, maintenance, depreciation intercst	.1062

Some English Notes on Activated Sludge Process

By ARTHUR J. MARTIN

Whenever a new and promising process for purifying sewage makes its appearance people are apt to jump at the conclusion that existing methods are doomed to be discarded. We had an instance of this 30 years ago on the advent of the septic tank, and history is repeating itself in the case of the activated-sludge process. This process has undoubtedly come to stay, but it is far more likely to supplement the older methods than to supersede them.

In the first flush of enthusiasm, too much was expected of the process, and it has been asked to do work for which it was not really suited. A common mistake was to rush the sewage into the aeration tank without adequate preparation. It is now realized that a preliminary settlement is desirable, and our old friend the sedimentation tank is accordingly coming into its own once more.

And it is by no means certain that it is always wise to dispense with filters. An activated sludge tank is very sensitive to change in the composition of the sewage. A sudden rush of liquid trade wastes may kill the organisms in the sludge, in which case it may take months to get it back into condition. The bacterial films in a trickling filter are hardier, and, as Mr. Whitehead, the engineer to the Birmingham, Tame and Rea Drainage Board, points out, the margin of aeration in a filter, and consequently its ability to cope with exceptional states of the sewage, is infinitely greater than given by any activated sludge plant.

Mr. Whitehead's predecessor, Mr. Watson, has drawn attention to another very significant point. The purification effected by the activated-sludge process is at first very rapid, but it soon slows down. Sixty per cent of the impurities of the Birmingham sewage are removed in the first hour; it takes five hours to remove another 30 per cent. A trickling filter would do it in an hour.

Sewage which has been treated for an hour with activated sludge is free from colloidal matter, and is much more readily oxidized than sewage which has merely passed through a sedimentation tank. As a result of this improvement, the quantity which can be purified by each cubic yard of filtering material is more than doubled.

Owing to the rapid growth in the population of the drainage district, the board was faced with the necessity for laying down an additional acre of filters each year to keep pace with the increased volume of the sewage. To obviate this need the board have laid down aeration tanks, or, as Mr. Watson prefers to call them, "flocculation tanks," between the sedimentation tanks and the filters. By so doing they increased the capacity of the filters twice or threefold, and the need for laying down any more beds has been indefinitely postponed. Not only so, but the nuisance which has been experienced from smell and from flies has been absolutely done away with.

Purification Standards.—Before designing works to purify sewage, we must know how far the purification will have to be carried. No question in connection with sewage has given rise to keener controversy than that of the standard of purity which should be aimed at. Opinions differ widely as to the nature of the tests which should be applied to effluents, their severity, and more particularly as to whether the standard should be enforced in all cases.

Various chemical tests have been proposed, framed, we may suspect, with more regard to the convenience of the chemist than to their actual value in practice. The rivers boards which have been set up in certain watersheds have adopted standards of their own, mostly different, which they apply to the effluents discharged into their rivers.

Too often these standards have been regarded as an end in themselves, instead of as a means for safeguarding the purity of the river. Little regard has been paid to the circumstances of individual cases, such as the character of the stream and the relative volumes of the diluting water and the effluents.

Lord Iddesleigh's Commission made an earnest attempt to put an end to this confusion, and recommended a common-sense standard to be applied in ordinary cases. In order to comply with this standard, the effluent must not contain more than three parts per 100,000 of suspended matter, nor absorb in five days more than two parts per 100,000 of dissolved oxygen. This standard, however, was not to be applied indiscriminately, for, as the Commissioners pointed out, the dilution afforded by the stream is the chief factor to be considered. When the volume of the stream, as compared with that of the effluent, is great, the standard should be relaxed, and with the dilution exceeding 50 volumes, all tests might be dispensed with.

All the standards now in force or proposed relate solely to the chemical qualities of the effluent. No one has yet ventured to advocate a biological standard. But it should never be forgotten that a sewage effluent, however highly it may be purified, is not suitable for use as drinking water. For the danger from sewage lies not in its chemical impurities, but in the possible presence of the germs of disease, and these are not destroyed nor removed with certainty by any of the processes in ordinary use. The effluent from a sewage works, however efficient, must therefore be regarded as potentially dangerous.

Acknowledgment.—The foregoing is an abstract of a paper presented Oct. 17 before the Institution of Mechanical Engineers of Great Britain.

Sanitary Aspect of Lake Michigan Diversion Case at Chicago, Illinois

A Non-Controversial Discussion of Chicago's Problem: Historical, Present Sewerage System—Efficiency of Sewage Treatment—The Water Supply—What Filtration Will Accomplish

By L. R. HOWSON

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FOR many years, the diversion of water from Lake Michigan by Chicago for sewage disposal purposes has been the subject of bitter controversy, culminating in a suit in the United States Supreme Court started about three years ago. The importance of the issue may be judged by the fact that about two-thirds of the people of the United States are parties in the litigation. The Supreme Court appointed Charles Evans Hughes as special master to take evidence which extended over a two-year period. In January, 1929, the Supreme Court made its initial findings, which required the Chicago Sanitary District to dispose of its sewage by means other than lake water diversion. This decree, when effective, will result in the discharge of part or all of the sewage plant effluents into the lake from which the water supply is taken. The practicability of safeguarding the public health under this program has been the subject of much debate. It is this phase of the case to which this discussion is directed.

A brief historical outline of Chicago's sewage disposal and water supply problems may assist toward an understanding of sanitary problems which the court's finding imposes upon the Chicago district.

Historical.—Chicago and the industrial region adjacent to it occupy the southwestern shore of Lake Michigan. The topography is comparatively level and most of the ground lies at an elevation less than 20 ft. above Lake Michigan. The city started near the mouth of the Chicago River, which was a small sluggish stream with a total drainage area of approximately 307 square miles, being made up of two branches, known as the north and south branches, which unite about one mile west of the mouth of the river.

The first sewers, as well as the first municipal water system, were built in 1856, at which time the city had a population of about 80,000 people. The occupied area was then so located that most of the sewers naturally drained directly to the main branch of the Chicago River and thence discharged directly to the lake. As the growth of the city increased, the expansion took place to the west, north and south, the natural drainage of which was either to one of the branches of the river or directly to the lake. The water supply has been taken from the lake from 1856 to date.

By 1890, the population had increased to 1,209,000 people and at the present time, exceeds 3,500,000 in the Sanitary District.

The discharge of the sewage into the lake within close proximity of the water works intakes resulted in high rates of water-borne disease in the Chicago district, the typhoid death rate reaching a peak figure of 173.8 per 100,000 in 1891.

In 1886, a drainage and water supply commission, known as the Hering, Artingstall and Williams Commission, was appointed to make a complete investigation of the subject of water supply, sewage disposal and drainage for the City of Chicago. This commission advised the construction of the drainage canal with a capacity of 10,000 cu. ft. per second and the construction of intercepting sewers which would divert the entire sewage from the lake and discharge it mixed with water drawn from Lake Michigan into the upper Des Plaines and thence into the Illinois and Mississippi water sheds.

As an outgrowth of this report, the legislature of the state of Illinois in 1889 passed the Sanitary District act and shortly thereafter the people of the district voted affirmatively on the creation of the Chicago Sanitary District.

Plans were prepared for the construction of a channel extending from a connection with the south branch of the Chicago River at Robey St. to a connection with the Des Plaines River near Lockport, a distance of some 28 miles. Construction was undertaken and the canal completed and placed in service in 1901 and since that date, the flow of the Chicago River has been from rather than into Lake Michigan.

The Calumet District to the south and east of Chicago continued to drain into Lake Michigan. In 1911, the construction of a channel known as the Calumet-Sag channel was started to divert the normal flow of the Calumet River from Lake Michigan to a connection with the drainage canal at approximately mid-distance between the Robey St. and Lockport ends of the canal. This channel was designed with a capacity of 2,000 cu. ft. per second. It was completed in 1922 and since that date, the flow of the Grand and Little Calumet Rivers has been away from rather than into Lake Michigan at such times as the stream flow did not exceed the carrying capacity of the canal and its connections.

The construction of the main drainage canal and the Calumet-Sag branch effected a remarkable improvement in the Chicago death rate from water-borne disease and to a large extent removed the sewage nuisance from the streams themselves. This result has, however, been accomplished by transferring the bad conditions in the Chicago and Calumet Rivers to the Des Plaines and Illinois Rivers in which nuisance has been created, all fish life killed and other damage resulted for more than 100 miles downstream. The Des Plaines and Illinois Rivers today are practically an open sewer for 150 miles distance from Chicago.

The important facts with respect to the typhoid death rate in Chicago are as follows:

Average for five years prior to opening of canal reversing flow—34 per 100,000.

Average for five years after opening of canal reversing flow—28.4 per 100,000.

Average for five years after completion of intercepting sewers diverting sewage from the lake—12.1 per 100,000.

Average for five years after the pasteurization of milk and the start of water chlorination—5.9 per 100,000.

Average for five years after complete chlorination of water supply—1.2 per 100,000.

The upper part of the diagram (Fig. 3) shows the typhoid statistics for Chicago for the period from 1890 to date. In this diagram are indicated the dates at which sanitary improvements were placed in service so that their effects may be visibly indicated.

The lower half of the diagram shows for comparison another important typhoid death rate reduction accomplished by water filtration, to which reference will be made later.

On Jan. 14, 1929, the Supreme Court of the United States delivered an opinion with regard to the diversion of water, which denied the right of diverting water at Chicago except that negligible quantity, if any, which might be required for navigation in the Chicago River as a part of the Port of Chicago.

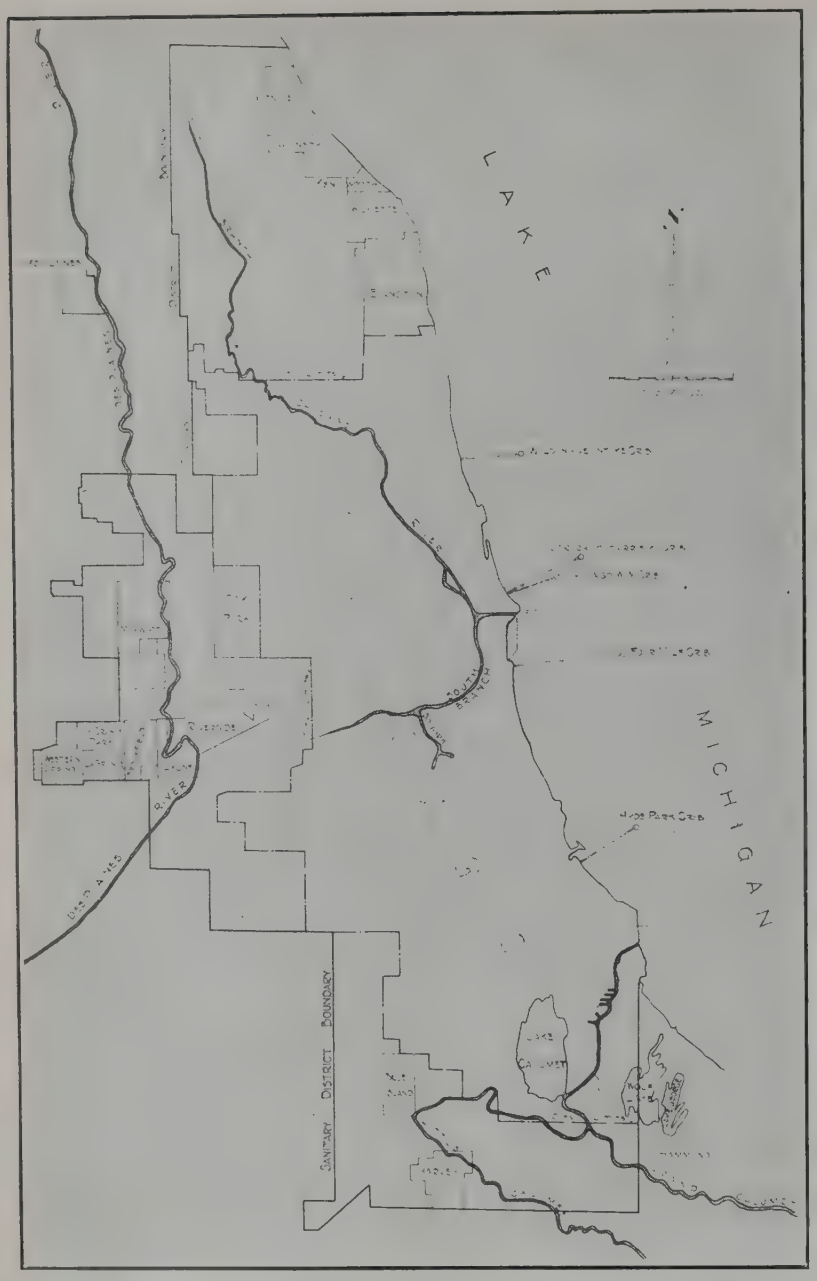


Fig. 1—Drainage Channels in the Chicago Sanitary District Prior to Diversion

In keeping, however, with the principles on which Courts of Equity condition their relief and by way of avoiding any unnecessary hazards to the health of the people of the Chicago section, the Supreme Court decided to so frame its decree as to accord to the Sanitary District a reasonably practicable time in which to provide some other means of disposing of the sewage, at which time there shall be a final permanent operative and effective injunction. The special master, Mr. Charles Evans Hughes, was instructed to take such further evidence as would enable him to advise the court as to:

1st: What negligible amount, if any, of diversion was necessary for navigation in the Chicago River as a part of the Port of Chicago.

2nd: What sewage disposal works would be necessary to care for the sewage of the Chicago district by means other than diversion.

3rd: What period would be required for the construction of such works.

This decree, when effectively carried out, will result in a part or all of the sewage plant effluent and storm water overflow being discharged into Lake Michigan, from which the water supply is taken. The water supply and sewage disposal problems at Chicago are and always have been one problem, though administered by two governmental agencies.

Present Sewerage System.—Sewerage in the Chicago Sanitary District is almost entirely on the combined system, although the Hering, Artingstall and Williams report, made in 1887, recommended separate sewers for the then outlying areas. Had that recommendation been adopted, nearly 80 per cent of the present sewer mileage would have been on the separate system and over 50 per cent of the population would have been tributary thereto. The problem of building intercepting sewers and of caring for storm water overflows would have been much simplified.

The Sanitary District now has under construction a comprehensive sewage disposal program including four major and several minor projects.

The North Side sewage treatment works have been finished. This is an activated sludge plant designed to serve approximately 800,000 people.

The West Side project, to serve 1,915,000 people as of 1945, has been started, originally as Imhoff tank treatment only, later to be followed by sprinkling filters, but since the Supreme Court decision, the Sanitary District has modified its plans for this plant so as to make it an activated sludge plant.

The Southwest side plant, which is to be located directly across the main drainage canal from the West Side plant, has not as yet been started. It is now planned to be an activated sludge plant to serve 1,320,000 people in 1945. The large stockyards organic load will be handled at this plant.

The Calumet project has been designed as an Imhoff tank and trickling filter plant to serve approximately 400,000 people. The tanks have been in operation approximately seven years. The sprinkling filters and secondary sedimentation are now included as a part of the Sanitary District's program to comply with the requirements of the United States Supreme Court.

Efficiency of Sewage Treatment.—While there has been some divergence of opinion, as reflected in the testimony, as to the quality of an activated sludge plant effluent, the operation of the Milwaukee plant, the largest yet in full operation, has demonstrated that the effluent from such an activated sludge plant in the sizes contemplated for Chicago, will be practically clear, odorless, colorless and stable and that the process will have removed at least 95 per cent of the suspended solids, at least 95 per cent of the bacteria, 98 per cent to 99 per cent of the b. coli and 96 per cent of the biochemical oxygen demand. It will contain 5 to 7 p.p.m. of dissolved oxygen and oxygen in the form of nitrates and nitrites up to 15 p.p.m. Based upon the Milwaukee operating experience, the remaining B. O. D. will be about 10 p.p.m. or less. It will be

permanently stable, that is, it will not again putrefy if stored in an open vessel or discharged into a water course in which it constitutes the total flow.

With a combined system of sewers, all of the sewage flow cannot be passed through the disposal plant on account of the relatively high ratio of storm water to sanitary flow. This necessarily results in the by-passing of some sewage during storms. It has been estimated that approximately 1½ per cent to 2 per cent of the sewage flow may reach the river channels untreated during the year, the exact percentage depending quite largely upon the capacity of the interceptors and the proportion of first storm flows which are carried through the plant.

The amount of storm water which could be discharged into the various water courses if all of the sewers were running full is approximately 12,000 c.fs. The interceptors are capable of taking about 4,000 c.f.s. to the disposal plants so that in extreme conditions 8,000 c.f.s. of mixed storm and sanitary flow would reach the streams.

The effluents from the various plants could be chlorinated so as to effect practically 100 per cent of b. coli removal if desired. It is somewhat more difficult to chlorinate the storm water overflow from over 300 separate outlets. All of this flow which may reach the lake, however, has to pass out through either the main Chicago River or the Calumet River and while the applying of chlorine to such large volumes has not been attempted to date, the results obtained in chlorinating raw sewage in large volumes would indicate its practicability. At the Cleveland Easterly plant, where the raw sewage from over 500,000 people is chlorinated, b. coli reductions have averaged over 96 per cent for the past three years and have exceeded 99 per cent when a chlorine residual of about .3 p.p.m. was carried.

So far as the sanitary aspect of the water diversion case is concerned, the question becomes one of the effect of activated sludge plant effluent and storm water overflows primarily upon the water supply and to a lesser extent upon the bathing beaches.

The Chicago Water Supply.—The Chicago water supply is drawn through four intake cribs located from three to four miles off shore and connected by tunnels to the 12 major pumping stations. The water receives no treatment other than chlorination.

About two-thirds of the time, the water drawn from the Chicago cribs is clear. It is often quite pure for short periods. However, its sanitary quality cannot be depended upon and for a considerable portion of the time at all of the intake cribs, it is distinctly bad. The water as delivered to consumers is often decidedly turbid for weeks at a time.

During 1927, the turbidities varied from 1 to 115 p.p.m. with a yearly average of 11.5 p.p.m. for all stations and 17.8 p.p.m. at the 68th St. crib. The water from the 68th St. crib had an average turbidity for a month of 50.4 p.p.m.

The net result from a sanitary standpoint is that the water as chlorinated has been good. The taste is frequently objectionable and the turbidity exceeds 10 parts per million on the average approximately 30 per cent of the time.

Filtration of the present water supply has been recommended by all conversant with the problem for a number of years. Filtration, however, carries with it the prerequisite of metering, for at the present time Chicago is pumping approximately 300 gal. per capita per day and the cost of filtration plants, sufficient to care only for the water wasted, would approximate $30,000,000. It has been estimated that if Chicago were to install meters on all services, in a 10-year period, there would be saved in the next 25 years $233,000,000 in operation and construction costs. In addition, it has been estimated that approximately $50,000,000 would be saved in the cost of intercepting sewers and sewage disposal plant construction. With complete metering, the quantity of water pumped, which it is assumed

Fig. 2—Drainage Channels in the Chicago Sanitary District After Diversion

is substantially the same as the sewage flow, will be approximately 1,000 cu. ft. per second between 1935 and 1940.

What Filtration Will Accomplish.—Filtration has demonstrated its ability to treat highly polluted waters satisfactorily. Among the notable examples are Niagara Falls and the Ohio River cities (Fig. 3).

Niagara Falls, whose water supply is polluted by the fresh sewage of Buffalo and environs, was one of the most important typhoid centers of the country, prior to filtration in 1913. The typhoid death rates were as high as 185 per 100,000 and averaged 125.8 per 100,000 for the 14 years preceding filtration. Following the start of filtration there were 18 months with no deaths from typhoid and the average typhoid death rate since filtration has shown a reduction of over 95 per cent from that prevailing prior thereto.

On the Ohio River city after city, from Pittsburgh to Cairo, takes its water supply from the river, returning the sewage again to the stream, the water being used again and again by the cities downstream after filtration. The b. coli index of the raw Ohio River water frequently exceeds 100,000. Filtration and chlorination produces from it a safe water supply.

In addition to the bacterial removal filtration will, of course, remove the turbidities now prevailing in the Chicago water supply.

Filtration will insure a clean water for Chicago 365 days in the year. Filtration should be installed at Chicago regardless of whether the diversion from the lake is zero or 10,000 c.f.s.

Chicago's Problem.—The Supreme Court having already decided that all diversion, except such negligible amount, if any, as may be required for navigation in the Chicago River, shall cease, the Chicago district is confronted with the necessity for devising such means of caring for its sewage and of protecting and purifying its water supply as will adequately safeguard the public health.

Among the measures available to accomplish this result, are the following:

1. The treatment of all sewage other than storm water overflow through the most efficient type of treatment plants which experts on both sides have agreed to be the activated sludge process.

2. The chlorination of the sewage disposal plant effluents.

3. The chlorination of all storm water overflows by carrying a residual chlorine content of approximately .3 part per million in the liquid flowing into the lake through the Calumet and Chicago Rivers.

4. The metering of the water supply which will make filtration practicable.

5. The filtration of the public water supply utilizing the present intakes and standard filtration methods.

6. The abandonment of those intakes nearest to the mouth of the rivers and the substitution therefor of a super-intake located approximately 20 miles to the northeast of the mouth of the Chicago River.

7. The modification of the standard filtration processes by double coagulation as is extensively practiced on the highly polluted Ohio River supplies or the adoption of excess lime treatment.

8. Sanitary control and sterilization of the bathing beaches.

9. Should the Supreme Court allow a diversion from the lake for navigation purposes in the Chicago River equivalent to the water supply and the run-off from the Chicago River watershed, it would be practicable through the operation of controlling works located at the river mouth or at the head of the canal to prevent any outflow of either sewage plant effluent or storm overflow to the lake.

Opinion as expressed in the hearings before Mr. Hughes has differed as to the measures or combination of measures which might be necessary to adequately safeguard the public health and the writer does not intend in this paper to discuss these controversial matters. It must, however, be apparent that if sanitary engineering science has not sufficently developed to safeguard the health of the Chicago community through a combination of sewage treatment and water purification works, a large part of the population of this and other countries is destined to live under unsanitary conditions. Chicago, in contrast to Milwaukee, Cleveland, Toledo and other important lake cities, is the only one at which diversion from the lake was a practicable possibility. Can anyone successfully argue that Cleveland or Milwaukee must cease to exist because of the necessity for living under conditions which are now to be imposed upon Chicago? The facts are that Cleveland's typhoid death rate with water filtration but with only 10 per cent to 15 per cent sewage treatment and Milwaukee's with complete sewage treatment, but with chlorination only of its water supply, are substantially the same as Chicago's under the present conditions of diversion from Lake Michigan. Certainly, Chicago with proper treatment of its sewage and with adequate purification of its water supply can continue to function and expand without detriment due to the decision of the Supreme Court.

Acknowledgment.—The foregoing is a paper presented at the recent meeting of the American Society for Municipal Improvements.

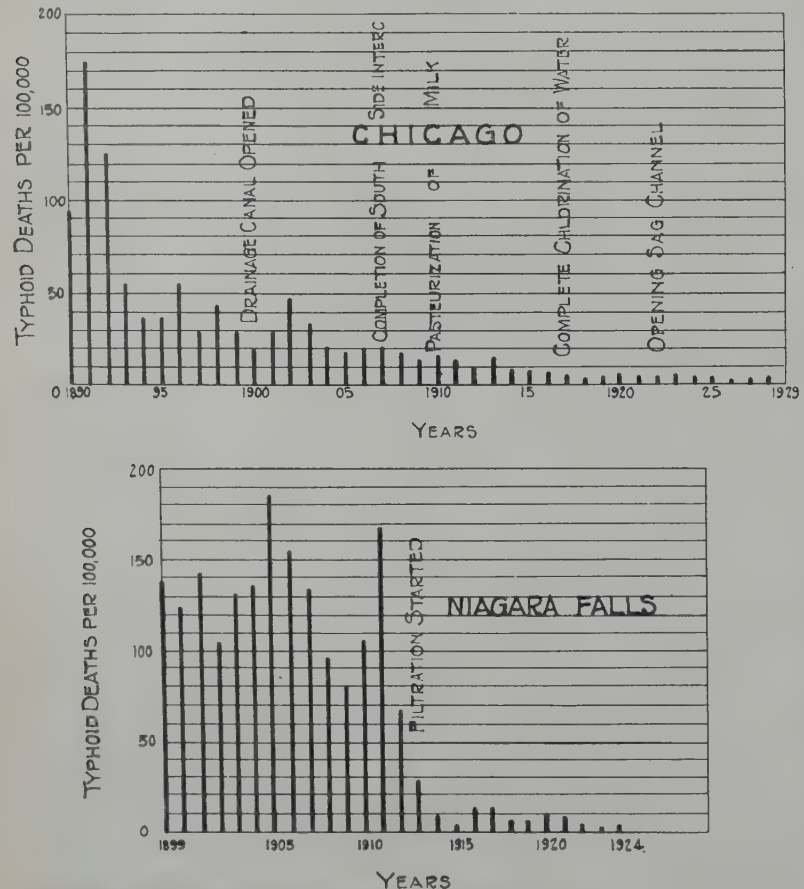


Fig. 3—Typhoid Fever Death Rates in Chicago, Before and After Diversion, and in Niagara Falls Before and After Filtration

Recreational Use of Reservoirs

Practice of the Department of Water and Power of the City of Los Angeles, California

By CARL WILSON

Laboratory Director, Department of Water and Power, City of Los Angeles, Calif.

AMONG the numerous phases of sanitation in connection with water supplies the question of recreational use of reservoirs impounding water intended for domestic consumption is one of perennial recurrence, seemingly incapable of final solution, at least for certain social elements.

From Cloud to Kitchen Tap.—First of all, as waterworks men and public officials, we are pledged to protect our consumers and to serve them with water which is not only safe, but which is made appetizing to thinking people by a history of clean antecedents all the way from cloud to kitchen tap. Can we afford to ignore this obligation in order to gratify the selfish instincts of a small proportion of the population? The demand to open our lakes does not proceed from a real necessity which must be satisfied—rather it is a luxury, to be indulged as becomes a luxury, certainly not at the expense of others.

We are told by those who advocate recreational use that fees can be imposed for the privileges granted, and the money so raised employed in police measures to prevent pollution of the water. Insofar as the majority of hunters and fishers are concerned the writer likes to believe such measures would be completely effective, but he has had too much experience with self-styled sportsmen to think we can depend upon patrolmen for the high degree of protection we require, and this statement is not to be considered in any degree as impeaching the integrity of these guardians of public safety.

The Advance of Sanitation.—Sanitary engineers tell us it is not only possible, but practicable, to convert the sewage of a city into pure and safe drinking water. Under the stress of circumstance this is already being done, while such procedure will probably become commonplace in the future, yet the thought of drinking reclaimed sewage is repugnant to most people. They want their drinking water kept clean all the time. It is true that purification methods have been so developed that it is possible to convert a grossly polluted river water into a safe supply for human consumption, but to accomplish it the works must be carefully designed and built and constantly watched by highly intelligent and thoroughly trained operators. Even then we find only too frequently that an outbreak of disease occurs through failure of some unit in the process in an unexpected manner. Where only a grossly polluted supply is available reliance must be placed upon purification, but in Southern California, where our raw waters are exceptionally pure, is it not better to maintain their purity than to run the risk of polluting them through human contact?

Recreational Use of Least Importance.—A committee on "Sanitary Conservation of Streams," reporting to the Eighth Annual Conference of State Sanitary Engineers at Chicago, states: "Strenuous efforts must be made to preserve the cleanliness of streams now in that wholesome condition."

The same report, when discussing the order of precedence of use of water resources, states:

"There can be no question that the use of water resources as the source of public water supplies is the first and highest use." Other uses, in order of precedence as set forth by this committee are, sewage disposal, navigation, manufacturing, industry, power, irrigation, agriculture, fishing, or recreation, as may be dictated by local circumstances. Recreational use seems to be regarded as of least importance. Is it wise to wilfully and knowingly run the chance of adding pollution of the most dangerous type to our water just because we think we can take it out? The writer does not believe such practice can be justified by any argument.

The Aesthetic Side of the Question.—Behind the questions of technology, and perhaps of greater effect upon the public mind, is what may be described as the aesthetic reputation of our water. Most people are fastidious in matters pertaining to food, and the present world-wide campaign to popularize knowledge in sanitary and hygienic matters is making them more exacting in this respect. Can we afford to ignore the demand of particular people that the public water supply shall not only be safe, but surrounded by such a clean and inviting environment as to create the belief that it is wholesome and appetizing.

Los Angeles Prohibits Recreational Use of Reservoirs.—For the last eight years Los Angeles has prohibited recreational use of her reservoirs, and we believe the results attained prove the wisdom of our action. Filtration is not practiced, reliance being placed upon natural purification during storage, supported by chlorination. Of course, natural purification in an impounding reservoir is not compatible with recreational use, for it demands at least thirty days' storage amid surroundings where re-pollution cannot take place. We depend upon and benefit through such natural processes to some degree, even in our terminal reservoirs, all of which store water for significant periods, and we cannot afford to sacrifice this advantage, which is really our margin of safety. Without filtration we have an enviable record for a safe water supply—not a single case of typhoid has been ascribed to our water since it has been municipally owned, a period of 27 years. Would our record have been as good had we permitted recreational use of our lakes? Perhaps, but the chance is great that the story would have had a different ending.

The Situation at Los Angeles.—The proposal is frequently made that remote reservoirs might be thrown open to public use, leaving those nearer the point of consumption completely protected. Under some circumstances it might be proper to adopt such a policy, but the Los Angeles system does not lend itself to such a compromise. Our Haiwee reservoir is 200 miles away from the city, in the midst of a practically desert region, but it is, biologically speaking, the key to our system. For more than a hundred miles to the north and west the Sierras send their creeks to feed Haiwee, and natural purification processes in this unique reservoir are depended upon to remove all pollution which may have occurred upon the catchment area, 3,300 square miles in extent. This immense drainage basin is one of California's greatest playgrounds, and no restriction of its use is required or contemplated. The public may hunt, fish, camp and otherwise enjoy this wonderland to the utmost, and Haiwee reservoir will function as a natural barrier to prevent the ill effects of intimate human association with the lakes and creeks from going beyond. But this will be true only if we prevent all pollution of the water in the reservoir. There must be an unbroken period of not less than 30 days during which natural purification can proceed to completion, hence we feel we must also deny recreational use even on our most remote lakes.

During the course of talks to clubs and schools in Los Angeles the writer has frequently put the question as to whether those present preferred recreational use of our reservoirs, and the response has always been overwhelmingly in favor of prohibition. Frankly, I believe this to be a true reflection of public preference in the matter and it has, at least in part, influenced our policy of restriction. Certainly those officials who are held personally responsible for the protection of over a

million and a quarter of human lives against the ravages of water-borne disease are not anxious to wilfully incur any risk, but must always err, if they err at all, upon the side of safety. We must be too strict rather than too lax, and it seems to me that we can conscientiously do nothing less than prohibit recreational use.

Acknowledgment.—The above is an abstract of a paper presented Oct. 25 at 10th annual convention of the California Section of the American Water Works Association.

Meter Testing and Adjusting Bills

By V. E. PERRY

Manager Water Sales Department, Spring Valley Water Co., San Francisco, Calif.

It has been the custom of the Spring Valley Water Co. ever since September, 1918, when San Francisco became 100 per cent metered, to test meters upon the request of a consumer who has a large bill and for which we have been unable to locate the cause.

Let us take, for example, a consumer who has had an increase of about 25 per cent or more in his bill and has received our usual letter (see Fig. 1) calling his attention to the increase and offering to make an examination if the excess has not been accounted for. If, after a careful examination of all the plumbing fixtures and check-up of the house piping, we are unable to account for the increase, we then order the meter tested. We use either of two methods of tests—one is an official test in which the city light and water inspector supervises the test, and the other is an unofficial test. The only difference in these tests is that the light and water inspector is present only in the official test. The test consists of measuring the water through the meter into a tank holding 10 cu. ft. Should a meter test within 2 per cent of 100 per cent efficient, we do not change the instrument, but for all meters that are either fast or slow 2 per cent or more we order a change for a new shop tested meter. As a rule, no increases are made for slow test meters. Our rules governing meter tests, copy of which has been accepted for filing by the Railroad Commission of the State of California, are as follows:

Rule 2. "If a consumer questions the accuracy of a meter supplying his premises, the Company will, upon the request of the consumer, cause an official test to be made at its own expense, provided the meter had not been tested within the period twelve (12) months prior to the date of said request. The consumer shall be notified of the time and place of such test, and may be present if he so desires.

(a) "In case the meter is found to be registering more than two per cent in excess of the actual quantity of water passing through it, another meter shall be substituted therefor, and the Company shall refund to the consumer the overcharge, based upon the correct meter readings, for a period of not more than twelve (12) months last past, unless it can be shown that the error was due to some cause, the date of which can be fixed. In the latter case the overcharge shall be computed back to, and not beyond such time.

(b) "Should more than one test during the year be demanded by a consumer, he shall deposit one (1) dollar with the Company and the test be made as provided in the preceding paragraph. Should the meter be found to register not more than two per cent in excess of the actual quantity of water passing through it, the deposit shall be retained by the Company. Should the meter be found to be registering more than two per cent in excess of the actual quantity of water passing through it the deposit shall be returned to the consumer and adjustment made as provided in the preceding paragraph."

We go a step further than the rules call for by making our adjustments for all meters that are 2 per cent or more fast. Our rules state "more than 2 per cent fast."

During 1928 out of 102,413 active metered services we tested only 494, or about ½ of 1 per cent. Of these 494 meters tested, 217, or 43.9 per cent, were found to be 100 per cent efficient; 193, or 39.1 per cent, were found to be slow; and only 84, or 17.0 per cent were fast. Of the 84 fast meters, 42, or 50 per cent, were 1 per cent fast; 21, or 25 per cent, were 2 per cent fast; 16, or 19 per cent, were 3 per cent fast; and 5, or 6 per cent, were 4 per cent fast.

In accordance with our rules, we refunded for the above fast meters the sum of $71 as follows: for 2 per cent fast $22.18, for 3 per cent fast $31.91, for 4 per cent fast $16.91.

As our gross revenue for 1928 was $6,565,450, our refunds account of fast meters of $71 were only about 1/1000 of 1 per cent of our 1928 revenue. This we believe to be a very favorable showing.

Acknowledgment.—The above paper was presented Oct. 24 at the 10th annual convention of the California Section of the American Water Works Association.

Recarbonation Equipment Installed at Manhattan, Kan.—With a view to facilitating softening and eliminating troubles due to after-precipitation, the city of Manhattan, Kan., has recently installed recarbonation equipment, the first in the state, as an adjunct to its water-softening plant. The equipment burns natural gas to produce the carbon dioxide.

SPRING VALLEY
WATER COMPANY

425 MASON STREET

WATER SALES DEPARTMENT
TELEPHONE PROSPECT 7000

SAN FRANCISCO.

We wish to report a noticeable increase in registered delivery of water for your account, as follows:-

Location:

This month's delivery:

Previous month's delivery:

Increase:

Unless you have reason to believe that the water was beneficially used, we would recommend immediate examination of the plumbing with a view to locating the cause for this large consumption and the repair of any leaky fixtures which may be found.

Very truly yours,

SPRING VALLEY WATER COMPANY

Telephone or write to Adjusting Counter

"Rust, corrosion, the hardening of rubber valves and other changes result in leakage from plumbing fixtures. Small leaks running constantly make little impression on people who do not realize their significance. Yet a leaky toilet may waste without attracting attention, as much water as would supply twenty families."

—From "METER RATES FOR WATER WORKS" by Allen Hazen.

Fig. 1—Letter Notifying Water Consumers of Unusual Increase in Water Consumption

Safeguarding Public Water Supplies

How Weather Conditions Affect Quality and Safety of Supplies

By ARTHUR E. GORMAN
Wallace & Tiernan Co., Newark, N. J.

DURING the last few weeks many New England cities and towns have sought permission from their respective state boards of health to use water from secondary and possibly doubtful sources due to shortage in their regular supply caused by prolonged drouth. Still how many of the officials in charge of these waterworks had kept sufficient data relative to deficiency in rainfall on their watersheds to enable them to predict this shortage and the approximate time the emergency would have to be depended on? And what is more—in how many instances had definite plans been made in advance as to the procedure to be followed when forced to use the emergency supply?

Planning for Emergencies.—A shortage of water for a public supply is a potential health hazard. Every water works system has its one or more weak points regardless of how well it was designed, built and is operated. It is encumbent on the directing waterworks officials to know these weak links when tested by every strain which may be brought on them by those elements called "weather" or any combination of them. He must know his factors of safety under normal conditions, under the extreme conditions which occur seasonally each year and under the most extreme conditions which may be expected every five years and every decade. Not only should he know this, but he should have developed a plan of action to be followed out during emergencies. A plan not housed in a vague way in his own mind but a plan which has been discussed carefully with his assistants and still better practised and put in writing for ready reference.

The average water works operator properly trained will carry on satisfactory under normal conditions and probably do reasonably well under somewhat unusual circumstances. But, these are not the conditions which precede outbreaks of typhoid fever and other water borne diseases. Sharp outbreaks or epidemics come as the result of a collapse in the fabric supposed to exist for public safety. They usually follow a simultaneous combination of circumstances which in accordance with the laws of probability will not be repeated in many years. It therefore behooves the careful water works officials always to be on the alert for emergencies.

One Emergency Problem.—Let us take up one emergency problem and some of its possibilities.

As practical water works men what would happen at your plants if it should rain at an excessive rate of precipitation for say three consecutive hours? Would your dam hold? Would flooding of sewers or sewage polluted streams affect your reservoir, clear well or tunnel shafts? Would water short circuit through your reservoir and cut your theoretical storage of forty days down to forty hours, thereby losing your factor or safety due to storage? Would your supply become turbid, necessitating the use of chemical coagulants? These are all possibilities at the more common type of water works in New England.

Chlorination Control System at Chicago.—During the four years that the writer was charged with the safety of Chicago's water supply, a control system for chlorination was developed which was based largely on a program of "watching the weather." Chicago's intakes in Lake Michigan are fixed. The sources of pollution of the lake are known. Therefore from a control standpoint it became necessary to learn all we could about those factors which would bring this pollution to our intakes. Our studies involved rates of rainfall and the effect of run off into the lake, the time and probable duration of river reversals, the effect of dispersion, the rate of drift of pollution in the lake and the influence of prolonged winds and barometric pressures on the lake levels. Automatic recording rain gauges at four places in the city made it possible to predict—even while the rain was falling—the probable affect the run off would have on the direction of flow of the rivers. Flow vanes at key points in the river equipped with alarm lights and bells gave warning of reversals; recording gauges showed river elevations while automatic recording instruments for wind direction and velocity told the story of what might be expected in the way of drift of pollution toward the intakes once it entered Lake Michigan. In other words, we studied our weak points, planned our campaign for control so that it might be put into operation while the emergency was brewing. Without such a system there would have been four or five occasions each year when we had no real factor of safety and would have operated on a wide margin of chance with the health of 3,000,000 as the stakes.

In the writer's opinion any unusual change in weather conditions, such as—excessive rainfall, high winds, prolonged drouth, excessive heat or cold—warrants the application of emergency operation pending investigation. No harm can come from playing safe. In Chicago with a predicted southerly wind the orders for increase in the chlorine to be used for sterilizing water from intakes exposed to potential pollution were always given. During the periods of rainfall the chlorine dosage was always raised at least ½ to 1 lb. per million gallons at all pumping stations as a safety factor against possible pollution of water in tunnels from sewers located near land shafts. Whenever emergency orders were issued they were not withdrawn until the results of bacterial examination of special samples collected during the emergency had indicated it was safe to do so.

Checking Special Measures Important.—From an operating standpoint it is highly essential that every water plant keep regular routine records of operation. But for protection it is of the utmost importance that whatever special measures are taken during emergency periods be checked for results obtained. Special raw water samples at the height of an emergency, supported by equivalent samples of the water delivered to consumers during the emergency and while your precautionary program is functioning, are of inestimable value. They not only tell you the story of the extent of your emergency by means of which you may be guided in the future should similar circumstances develop, but they serve as your protection in case of controversy resulting from the emergency itself. At Chicago we prepared for these emergency samples by storing special sterile bottles at all sampling points and having emergency sampling equipment on hand at the laboratory for immediate use at any time.

Weather Conditions Should Be Studied.—It is obvious that the smaller water works cannot afford to have the expensive equipment considered necessary at large cities. But still there is no reason why the officials of smaller water works cannot apply fundamental precautions indicated as desirable through a keen study of weather conditions and their relation to the peculiar conditions at their respective plants. Make it a point to study the affect and influence of every unusual period of weather on the operation of your plant and the quality of the water delivered therefrom. Watch for the unusual with that unceasing instinct which makes the experienced Yankee sailor put into port with the first threat of a so' easter.

The water works official who is always on the alert for the unusual rarely has to meet with serious emergencies. He instills into his men that element of watchfulness and carefulness which prepares them to meet the more than average emergency with calm. He steels them to a degree of efficiency and discipline which makes it possible for him to get prompt and effective response to his directions when the real emergencies arise.

Emergencies of any kind in supplying safe water to consumers have a distinct public health aspect. For this reason it is the part of wisdom for the water works officials to take into their fullest confidence the health officers charged with supervision over public water supplies. The weak points in any water works should be known to the health officer. His advice should be sought in establishing a control program. He should be notified of emergencies as they develop or threaten. Your experiences reported to him may save the day for some other water works at a later period; or conversely a warning from him based on a report from some other operator may be just in time to permit you to take the proper control measures. An outstanding example of this is the cooperative program developed through the Ohio River Interstate Stream Pollution Agreement for notification through the state departments of health of water works operators of spills of phenol wastes on the Ohio river watershed.

In conclusion, this paper is a plea to the water works officials to "watch the weather"—that they may know its relations to the weak features of their respective plants; that they may work out an effective plan of action when emergencies arise; and that they may work in full harmony and cooperation with the proper health authorities in producing for the consuming public at all times, clean, safe, wholesome water.

Acknowledgment.—The foregoing is an abstract of a paper presented Sept. 20 at the 48th annual convention of the New England Water Works Association.

Leakage and Wastage at Cambridge, Mass.—The report of the Water Board of Cambridge, Mass., for the year ending March 31, 1929, contains the following:

In 1919, a pitometer survey was made on the system. The City was divided into twenty-two sections and a careful inspection was instituted for leakage and wastage. This year the city was again surveyed, and in seventeen sections the consumption was practically the same as noted in 1919. But in five sections the consumption had increased from 50 per cent to 100 per cent. This increase may be traceable to the additional population due to the construction of apartment houses, of from 20 to 30 suites, which replace the demolished old houses formerly containing one or two families.

Electrically Illuminated Fountain for Filtration Plant

An electrically illuminated fountain, having a number of unusual features, has been installed recently in the park at the filtration plant at Peterborough, Ontario. The installation was described by R. L. Dobbin, General Manager of the Utilities Commission of Petersborough in a recent issue of the Contract Record, from which the notes following are taken.

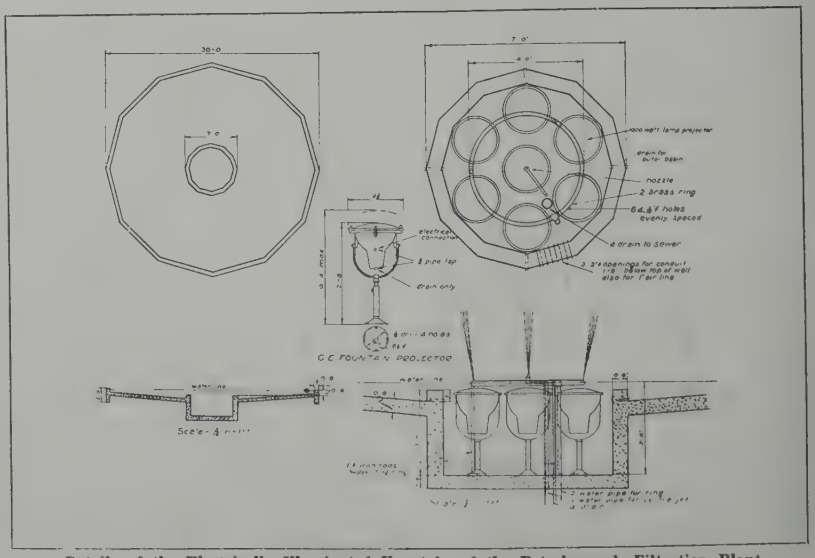
The fountain was designed and installed by the staff of the Petersborough Utilities Commission. It is designed along somewhat unusual lines specially for night illumination purposes.

The fountain itself consists of a shallow pool, dodecagonal in shape, with a center well which houses the lighting projectors and water jets. This is indicated in the detailed drawing. When the fountain is not operating, the only thing visible in the 30-ft. pool is the center nozzle and the top of the 4-ft. spray ring which is half submerged in the center. When in operation the spraying apparatus, of course, is not visible.

The seven projectors, supplied by Canadian General Electric Co., are of the submerged type, each containing 1,000 watt lamps. The one in the center, immediately under the central nozzle, contains a clear lens and the six others arranged on the points of a hexagon (in alternate corners of the dodecagonal wall) under the spray ring are red, green and amber—two of each color.

Current at 110 volts, a.c., is supplied to the projectors through underground lead cables from a flasher that is located in a manhole at a short distance from the fountain. With this arrangement, various combinations of colors are obtained and the flasher may be adjusted while the fountain is in operation. The central jet of water attains a height of 35 ft. and the outer 4-ft. ring of fine spray a height of 10 ft.

During the summer the ever-changing colors against a background of green trees and shrubs have attracted a host of visitors to the park and filtration plant.



Details of the Electrically Illuminated Fountain of the Peterborough Filtration Plant

State and Municipal Bond Election Results During September

New state and municipal bond authorizations reported during September broke all previous records for this year, according to The Daily Bond Buyer, of New York, whose regular compilation shows authorizations by 83 states and municipalities totaling $84,308,700. This compares with $16,870,199 in September last year, $13,372,949 in September, 1927, and $36,164,949 in 1926.

The unusually large total of authorizations last month is largely accounted for in the $55,000,000 program of the city of Philadelphia and $16,200,000 for the state of Maine. Other large items were $3,500,000 Hidalgo and Cameron Counties, Texas, Water Control and Imp. Dist. No. 9, and $1,000,000 Spartanburg, S. C., Sanitary Dist.

Issues defeated amounted to $10,182,600, as compared with $9,707,500 in September last year, $12,292,250 in September, 1927, and $4,178,500 in 1926. Among the larger projects defeated by the taxpayers of 34 communities were $4,070,000, Jefferson County, Texas; $3,000,000, Tacoma, Wash.; $800,000, San Augustine County, Texas, and $453,000, Falls County, Texas, Road Dist. No. 4.

A 22.4-Year Cycle in Rainfall and Its Cause

Analysis Employs Tree Growths, Clay Varves and Sunspot Records Guided by Electromagnetic Whirl Theory

By HALBERT P. GILLETTE

THE accompanying chart shows a rainfall cycle of about double the so-called 11-yr. sunspot period. It is particularly interesting in that the supernormal rainfall of one 11-yr. period is almost exactly offset by the subnormal rainfall of the succeeding 11-yr. period. This chart was recently sent to me by Mr. Burt Harmon, Hydraulic Engineer of the Water Department of Long Beach. I have inserted the dates of the Jupiter sunspot cycle, showing both its date of maximum and minimum effect. It will be noted that Mr. Harmon's 11-yr. periods should be shifted about a year to the right to correspond with the Jupiter sunspot dates; but that doing so does not appreciably alter his calculations of excess and deficient rainfall for each of the 11-yr. periods.

In an article published in "Municipal News and Water Works," October, 1928, I had shown that it is sunspots of south polarity that cause barometric lows, and that it is their preponderance over sunspots of north polarity that largely determines the amount of rainfall. Coupling this fact with Hale's discovery that the leading sunspots have opposite polarities in the sun's two hemispheres and reverse their polarity about every 11.2 years at about the time of sunspot minimum, I had indicated the reason for a 22.4-yr. rainfall cycle; but none the less I was surprised by the striking character of Mr. Harmon's chart. I decided, therefore, to test my theory more fully by taking the data of radial growth of pine trees for 500 years, as given by Douglass, checking the quantitative facts derivable therefrom against my theory. Table I shows the result of this analysis, which yields an almost perfect check of theory against fact for 43 out of 45 cycles of 11 years each. Had all 45 cycles checked the theory as did the 43, such an occurence could happen by mere chance only once in 35 trillion times. However, taking only the 30 cycles subsequent to 1570, in which not one departs from the theory, the probability ratio is ½ raised to the 30th power, making the odds about one billion to one that this coincidence is not fortuitous. Since the theory is thus shown to be in accord with the facts, by odds that are overwhelmingly against the accordance being accidental, it may be regarded as being established as true in so far as it explains the phenomenon in question.

Briefly reviewed, the theory of this phenomenon is as follows: The sunspots, as Hale has proved, are electromagnets, often of tremendous power. Any magnet causes free electrons to rotate around the magnetic lines of force, as laboratory experiments have shown. Electrons thus rotating themselves constitute an electromagnet, as is clearly seen in the case of solenoids. The earth itself is an electromagnet and so is the air above it, for both contain free electrons that are carried around by the earth as it rotates on its axis. Hence, these two magnetic fields must give rotation to free electrons in the air, that is, they must generate cyclonic whirls of electrons in the air. But such whirls in turn are electromagnets and tend to migrate under the action of the magnetic fields. The fields that may effect such migration are numerous, including certainly the earth's two great fields, the sun's great field, the fields of the sunspots and the fields of the planets.

The fact that cyclones rotate in opposite directions in the earth's two hemispheres is in accordance with the theory that the two magnetic poles of the earth would produce opposite rotations of the cyclones. If an ascending cyclonic whirl of air bends backward, it will tend to descend as an anticyclone. The alternation of lows and highs where storms travel across a continent and several other facts bear out this influence. Sunspots commonly occur in pairs that rotate in opposite directions, showing close analogy with our cyclones and anticyclones. But whereas our cyclones never reverse their polarity (or direction of rotation), sunspots reverse it about every 11.2 years.

The magnetic north pole of the sun lags behind the rotation of the photosphere, or moves relatively westward, as Hale has shown. Let this also be the case with the planets and let their magnetic fields be sufficiently powerful, and it follows that they must produce magnetic disturbances in the sun's atmosphere, by causing changes in the density of the free electrons in different parts of that atmosphere. These changes must be most pronounced when the magnetic axis of a planet points most nearly toward the sun, which will be oftener than the orbital period of the planet. This gives an explanation of the difference between Jupiter's orbital period of 11.86 years and the great sunspot period of 11.2 years.

I have found that Uranus produces a sunspot cycle of 81.15 years (its orbital period being 84 years), its last maximum being July, 1870. Uranus is far more powerful than Jupiter in its sunspot effect, probably because its rotative axis is so greatly inclined that its magnetic axis points much more directly at the sun than does that of Jupiter.

Uranus and Jupiter are two great sunspot generators, the latter being exceedingly important because of its relatively short cycle of 11.2 years. Its last well-established maximum sunspot effect was Aug. 12, 1917, or 1917.6; and I have counted backward from that date to establish the 11-yr. cycles in Table I. The last year of each of the cycles in that table is the year in which a Jupiter sunspot maximum effect occurred. This does not mean that there was invariably a maximum of spots in that year, for Uranus, Neptune and perhaps a trans-Neptunian planet at times submerged Jupiter's effect. It is noteworthy, however, that of the 28 recorded sunspot maxima from 1615 to 1917, 17 occurred within a year of the dates that I have assigned to Jupiter maxima, and that 6 others are fully explained by the Uranus and Neptune dates of maxima, leaving but 5 not explained with great precision.

Neither Jupiter nor Uranus produces a sunspot maximum oftener than once during an orbital revolution, which indicates that only one end of its magnetic axis is effective in causing sunspots.

The total number of spots in the sun's two hemispheres is seldom even approximately equal during any two successive 11-yr. periods. Prior to about 1850 the number of spots in the sun's northern hemisphere exceeded those in the southern hemisphere, but since then the contrary has been the case. If cyclonic storms are more numerous and intense the greater the preponderance of sunspots of south polarity and if the polarity reverses every 11.2 years, it follows that so long as there is a preponderance of sunspots in the sun's southern hemisphere, then there must tend to be alternate 11.2-yr. periods of wet and dry weather, provided only that the spots of the new cycle wax rapidly while those of the old cycle wane rapidly in number. Whether this order of waxing and waning occurs or not may be readily ascertained by comparing the average percentages of spots in the two hemispheres, thus:

Period	Per Cent N. Hemisphere
1874-84	43
1885-95	38
1896-06	48
1907-17	45
1918-28	56

The percentages above given are average annual percentages of spotted area (Greenwich data) deduced from a

table given by Clough in "Monthly Weather Review," July, 1928, p. 262. The alternate increase and decrease in percentage for the 11-yr. periods confirms the inference above made.

On the other hand if we take 11-yr. periods from minimum to minimum (instead of from maximum to maximum) of Jupiter sunspot effect, we get the following results:

Period	Per Cent N. Hemisphere
1880-90	38
1891-01	42
1902-12	42
1913-23	57

For the first three of these periods we have an almost exact equality of spotted area in the two hemispheres. Then follows a sudden marked increase, the duration of which is problematical.

In the light of the results shown in Table I, it is very clear that for many 11-yr. periods, there has been alternate rapid and slow growth of the Arizona pines, just as during the 5 cycles from 1874 to 1928 there was an alternation in the percentage of spotted area.

Study of Table I shows that there have been three times since 1403 when the cycles of wet and dry periods of 11 years reversed themselves, namely, the periods of 1515-25, 1638-48 and 1862-72. This indicates that about these times the percentages of sunspottedness in the sun's hemispheres reversed themselves. The earliest accurate records of percentages of spottedness in the two hemispheres are those of Carrington and Spoerer, which are given in Clough's article above mentioned, from 1854 to 1890. For the year 1854 there were 61 per cent of the total number of spots in the sun's northern hemisphere; in 1855 it had dropped to 49 per cent; in 1856 to 37 per cent and from 1856 to 1873, inclusive, it averaged 47 per cent. The data subsequent thereto, but using areas instead of numbers of spots, are given above. It appears, therefore, that about 1856 the spottedness of the sun became greater in its southern hemisphere; and it is to be noted that the 11-yr. cycle that followed this date is marked in Table I as one in which a reversal of cycle occurred. So the only quantitative record of change in relative spottedness in the two hemispheres agrees with the evidence of such a change as derived from the growth of the Arizona trees.

The date of the next reversal of cycle is problematical, for Table I shows two different lengths of time between reversals, namely, 123 years and 224 years.

The cause of the shifting of the majority of sunspots from one hemisphere to the other seems to be the positions of the slower-moving planets relative to the sun's equator.

Huntington (pp. 211 and 216) states that Stewart, Maunder and Pocock independently found that sunspots are either more numerous or larger on the sun's face that is more remote from Mercury, Venus and Earth. In his "Astronomy" (p. 35) Chambers says that Stewart (in his investigation of the effect of Venus) found that spots tend to break out on the face of the sun nearest Venus, but attain their maximum when they are on the face farthest from Venus. It follows, therefore, that a slow-moving planet having an orbit considerably inclined to the sun's equator would probably cause more sunspots north of the equator during one-half of its orbital period, and the converse during the second half. I am inclined to think that one or more unseen planets beyond Neptune are mainly responsible for the greater changes in the sunspot preponderance in the sun's two hemispheres.

If I have spoken with a good deal of assurance about the length and constancy of the Jupiter sunspot cycle, it is not merely because the data in Table I very strongly support such an inference.

Long before this table was prepared, I had found just as convincing evidence

Table I.—45 Periods of 11 Years' Growth of Arizona Pines Showing Alternating Cycles

11-Year Period	Average Yearly Growth m. m.	Theoretical Relative Rainfall	
1403-13	1.94	Wet	(Uranus peak, year 1384)
1414-24	1.40	Dry	
1425-35	1.41	Wet	
1436-46	1.05	Dry	
1447-57	1.25	Wet	
1459-69	1.19	Dry	(Uranus peak, year 1465)
1470-80	1.25	Wet	
1481-91	1.04	Dry	
1492-02	1.08	Wet	
1504-14	.90	Dry	
1515-25	.92	Dry	(Reversal of Cycle)
1526-36	1.18	Wet	
1537-47	1.22	Dry	(Uranus peak, year 1546)
1548-58	1.61	Wet	
1560-70	1.56*	Dry*	
1571-81	1.15*	Wet*	
1582-92	1.06	Dry	
1593-03	1.30	Wet	
1604-14	1.22	Dry	
1616-26	1.31	Wet	(Uranus peak, year 1626)
1627-37	0.79	Dry	
1638-48	0.79	Dry	(Reversal of Cycle)
1649-59	0.83	Wet	
1660-70	0.73	Dry	
1672-82	1.00	Wet	
1683-93	.90	Dry	
1794-04	1.04	Wet	
1705-15	1.05	Dry	(Uranus peak, year 1708)
1717-27	1.08	Wet	
1728-38	0.67	Dry	
1739-49	0.77	Wet	
1750-60	0.65	Dry	
1761-71	0.76	Wet	
1773-83	0.54	Dry	
1784-94	0.71	Wet	(Uranus peak, year 1789)
1795-05	0.63	Dry	
1806-16	0.61	Wet	
1817-27	0.49	Dry	
1829-39	0.67	Wet	
1840-50	0.49	Dry	
1851-61	0.70	Wet	(Uranus peak, year 1870)
1862-72	0.71	Wet	(Reversal of Cycle)
1873-83	0.46	Dry	
1885-95	0.43	Wet	
1896-06	0.40	Dry	

*Only 2 of the 45 periods fail to agree with the theory and this is one of the two.

Note: These annual tree-growths are averages deduced from a table given by Douglass for trees at Flagstaff, Arizona, without adjustment for a declining rate of growth with increasing age of trees. In determining the relative rainfall (whether "wet" or "dry"), the contrast should always be made between the 11-yr. periods that are close together; and if it is desired to ascertain whether a given 11-yr. period is "wet" or "dry" compared with the 11-yr. periods before and after, add the average annual rate of tree-growth immediately before the given 11-yr. cycle to the rate of immediate growth following, and divide by 2. If the quotient is a rate of growth in excess of that shown for the given 11-yr. cycle, then that cycle is relatively "dry."

of the stability of the Jupiter sunspot cycle. Take, for example, the fact above mentioned that by assigning a length of 11.2 years to the Jupiter cycle, 17 of the 27 known sunspot maxima from 1615 to 1917 fall within a year of the calculated Jupiter maximum period. Deduct 5 of the 27 known specks because they were caused by Neptune and Uranus, and there are left 22 of which 17 fall within a year of a calculated Jupiter maximum. Since the Jupiter cycle is 11.2 years; if a spot maximum occurs within 1 yr.., on one side or the other of a Jupiter maximum, we have $2 \div 11.2 = 0.18$, which is the probability ratio of its occurrence purely by accident, or about 1 chance in 5. That 17 of 22 such coincidences occurred could have happened purely by chance only once in 88,414,400 times.

Between the sunspot maxima of 1615.5 and 1917.6 there are 27 cycles of 11.19 years. It is admitted that Wolf's determination of the 1615.5 date is approximate. But fortunately there are two very early dates when very large sunspots were seen by the Benedictine monk Adelmus, namely, Mar. 17, 807, and May 28, 840. These dates are 33.195 years apart, or 3 cycles of 11.065 years, which is close to the Jupiter cycle as to leave little doubt that they were both near the times of a Jupiter sunspot peak. From Mar. 17, 807, to Aug. 12, 1917, is 1110.4 years. If 99 cycles intervene, they average 11.216 years; if 100 intervene, they average 11.104 years. So many other facts indicate that the cycle is about 11.2 years that the 11.216 is probably very nearly correct. If we divide the 1077.2 years between May 28, 840, and Aug. 12, 1917, by 96 we get 11.22 years. According to Chambers (p. 44) Hakluyt saw "a great black spotte" Dec. 7 to 16, 1590, or 326.3 years prior to Aug. 12, 1917, which divided by 29 is 11.248 years. It is significant that the Douglass table of Arizona (Flagstaff) pines shows an exceptionally great growth in 1589, only a year earlier than the Hakluyt observation; and the Douglass table of California sequoia growth likewise shows a peak in 1589. This last-named table furnishes many excellent opportunities to test the theory that there is a cycle of about 11.2 years. I will mention only 3 of scores of similar calculations that I have made, using the sequoia growth tables. In 1157 B. C. and again in 1146 B. C. (11 years later), there were extraordinarily great thicknesses of wood deposited in these trees. From 1157 B. C. to 1917 A. D. is 3074 years, or 274 cycles of 11.215 years. An exceptionally great growth occurred in 663 B. C., which is 2580 years prior to 1917 A. D., and 230 cycles make the average 11.217 years.

Table II gives the years of sunspot maxima as far back as sunspot counts have been accurately made. It also gives the dates that I have assigned to Jupiter's maximum sunspot effect, the Jupiter cycle being 11.21 years.

See an article in the October, 1929, issue of "Water Works and Sewerage," on Five Important Weather and Earthquake Cycles.

The table shows that for the last 8 sunspot maxima, there has been an alternation of high and low numbers of spots. During this period of 80 years, Jupiter has not been seriously interfered with by any planet, except when Uranus produced the peak of 1870.5. The previous peak period of Uranus in 1789 and that of Neptune in 1778 seriously interfered with Jupiter effects. In fact neither in 1783 nor in 1794 did Jupiter cause many sunspots, because of the effects of the magnetic fields of Neptune and Uranus upon Jupiter's field. Because their axes lie almost in the planes of their orbits Neptune and Uranus produce very powerful magnetic effects on the sun, Jupiter and earth.

Although Jupiter causes its maximum sunspot effect only once in 11.2 years, when its north magnetic pole points most directly sunward, it usually causes pronounced weather disturbances when its south magnetic pole (as well as its north magnetic pole) points most directly earthward.

I am inclined to think that sunspots change their polarity every 11.2 years, because there are two magnetic fields on the sun (corresponding to the two on the earth) which alternate in their control of the rotation of sunspots. If electrons are carried aloft as a result of the action of the lower field during one 11.2-year period, then the upper field is closer to the most highly electrified intermediate atmosphere of the sun, and during the succeeding 11.2 years the upper field gives rotation in an opposite direction to the sunspots and discharges streams of electrons back toward the lower fields. A similar effect could be secured by the periodic warping of the two fields under the magnetic attraction and repulsion of the sunspots.

If one of the two fields is stronger than the other, it follows that the 11.2-year sunspot peaks would alternate in intensity.

Sunspot Peak Year	Average Number of Sunspots	Date of Juipter's Max. Sunspot Effect	
1706	49	1704.6	
1718	50	1715.8	
1727	90	1727.0	
1739	85	1738.2	
1750	83	1749.4	
1761	85	1760.6	
1778	155	1771.9	(Neptune peak in 1783.1 1778-4)
1787	132	1794.3	(Uranus peak in 1789.3)
1804	47	1805.5	
1816	45	1816.7	
1830	71	1827.9	
1837	137	1839.1	
1848	124	1850.3	
1860	95	1861.5	
1870	139	1872.8	(Uranus peak in 1870.5)
1884	63	1884.0	
1893	84	1895.2	
1906	62	1906.4	
1917	100	1917.6	
1928	76	1928.8	
		1940.0	(Neptune peak in 1939.8)
		1951.2	(Uranus peak in 1951.7)

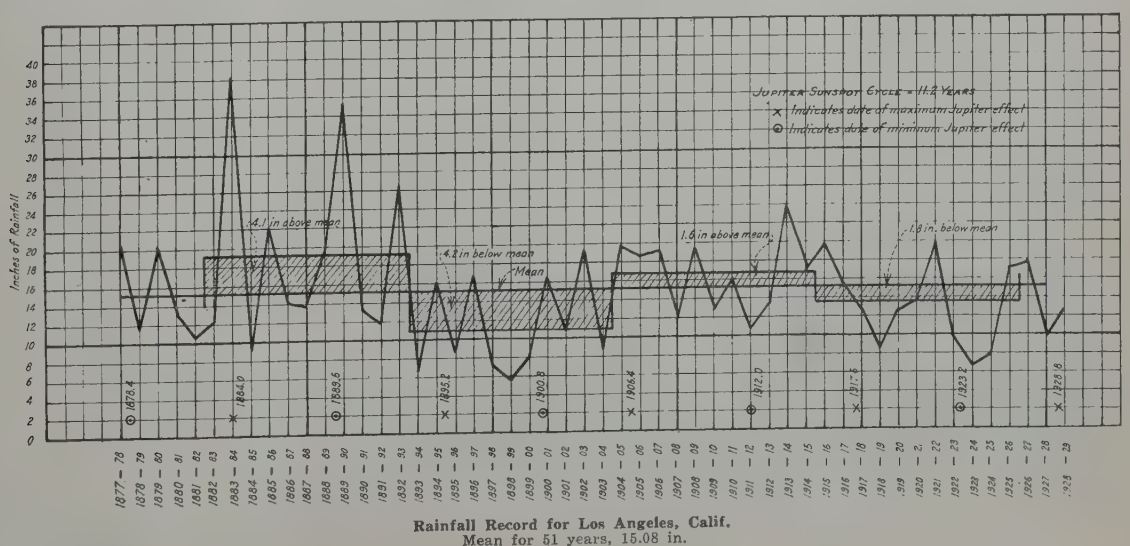
Note: The sunspot numbers prior to 1750 are those given by Fritz (Monthly Weather Review, October, 1928, contains a translation of his paper). The dates of Jupiter's maximum sunspot effect are based upon a sunspot period of 11.21 years deduced by the author. See "Water Works and Sewerage," October, 1929, for a discussion of Jupiter's cycle and those of 4 other planets.

Although the sequoia trees furnish a very long chronology of weather changes, a much longer one is to be found in Baron Gerard de Geer's clay varve charts, given in his great article, "On the Solar Curve as Dating the Ice Age, the New York Moraine and Niagara Falls," "Geografiska Annaler," 1926, H. 4. An English translation of this article was received from Baron de Geer (whose address is Sveavagan 32, Stockholm, Sweden), and its charts have enabled me to calculate the length of the Jupiter sunspot cycle with great precision. Baron de Geer had, of course, seen that there is a frequently recurring cycle of 11 years in the thickness in the clay varves, or layers of clay annually deposited in ancient glacial lakes. The zero year of his varve time scale is about 6800 B. C. From 1077 to 1580 on his time scale is 504 years, and there are peaks in his chart at those dates that are clearly peaks in an 11-yr. cycle; $504 \div 45 = 11.200$ years.

On his chart in the year 6975 of his scale there is a peak that is also clearly one of a series of 11-yr. peaks; hence, from 1077 to 6975 is 5,898 years which divided by 526 gives 11.213 years, and divided by 525 gives 11.234 years. Judging by the sunspot data and the tree-growth data, the proper division is 526. If so, Jupiter's sunspot cycle is very nearly 11.213 years.

This seems to be the acme of accuracy attainable at present until it is remembered that Baron de Geer has stated that he feels very sure that his zero year is within a century of being 6800 B. C. If so, it becomes possible to tie his clay varve chronology to our Christian chronology with accuracy, if we know quite closely two sunspot cycles. As above stated the Uranus spot cycle is very clearly marked both on the sunspot curve and on the tree growth curves. I had found it to be 81.15 years, its last peak being in July, 1870. Study of the clay varve chart indicated Uranus peaks in 1185 and 6784, to name only two extreme years that were clearly defined. Those years are 5,599 years apart, and 69 cycles, give 81.145 years as the Uranus cycle. Using this Uranus cycle and a Jupiter cycle of 11.214 years, I was able to show that de Geer's zero year is 6766 B. C., provided his 6806 B. C. estimate is within 200 years of the correct date.

Table I clearly shows the effects of 7 sunspot peaks due to Uranus; the first one in 1384 is foreshadowed in the great growth of 1403-13. The next one, in 1465, finds full expression, for although the decade of 1459-69 shows an average growth below that of the preceding and the following decades, that is because it lies in a dry period. If we take the 3 periods (11-yr.) that center around each of the 6 Uranus peaks of



Rainfall Record for Los Angeles, Calif.
Mean for 51 years, 15.08 in.

1465, 1546, 1626, 1708, and 1789, and 1870, and the 3 periods that center around each of the 6 Uranus valleys of 1425, 1506, 1586, 1668, 1749 and 1830, we find that there was 21 per cent greater tree growth during the 6 Uranus peak epochs (of 33 years each) than during the 6 Uranus valley epochs (of 33 years each); this calculation being based on data of growth equated for declining growth with increasing age, as per the Douglass chart. The six 11-yr. periods nearest a Uranus peak show a 29 per cent greater growth (equated) than do the six periods nearest a Uranus valley.

Douglass found that the tree growth at Prescott correlated with the rainfall at Flagstaff, 12 miles away, in 70 per cent of the year during which rainfall records had been kept. There is thus established a very satisfactory agreement between Arizona tree-growth and rainfall.

Earth Dam and Spillway, Mango, Ill., Impounding Reservoir on the Edgewood Cut-Off of the Illinois Central

Horseshoe Spillway Solves Problem of Limited Space

Among the many problems incidental to the building of the Edgewood cut-off of the Illinois Central System was the development of a complete water-supply system having a capacity adequate for the needs of future years. The line, which extends from Edgewood, Ill., to Fulton, Ky., has a length of 169 miles and the total annual volume of water required, estimated at 336,000,000 gal., was divided among eight water stations. Aside from the major aspects of the problem of obtaining a suitable supply, many of the details of the project furnished an outlet for the ingenuity of the designers.

One such instance occurred in connection with the Mango, Ill., supply station. Here the water station is supplied from a reservoir having a storage capacity of 109,000,000 gal. and covering an area of 33.8 acres. The total annual runoff draining into the reservoir is estimated at 125,880,000 gal., a quantity which is far in excess of the estimated maximum annual consumption of 40,000,000 gal. The water is impounded by an earth-fill dam, paved with concrete on the reservoir side to prevent erosion. The unusual feature of this dam is the spillway. Space was limited and, in order to secure a length of crest sufficient to care for the excess runoff, the spillway was built in the form of a horseshoe. Dam and spillway are shown in the accompanying illustrations. The spillway has a length of 88 ft. The dam is 523 ft. long and 30 ft. high, and contains 38,300 cu. yd. of earth. A concrete toe wall and a cut-off wall of Wakefield sheet piling are provided at the toe of the fill. The downstream slope is sodded.

Horseshoe Spillway of the Mango Dam. This Design Was Made Necessary by Limitations on the Space Available

The water development along the Edgewood line was under the direction of C. R. Knowles, Superintendent of Water Service for the Illinois Central.

Cleaning Rusty Pipes with Steam

Recent experiments in the removal of rust incrustations from steel pipe with steam are declared to have been successful. The pipe is filled with steam for about 15 minutes and then flushed with cold water, which carries away the loosened scale. These operations are repeated until flushing brings down no more of the oxide, indicating that the inside of the pipe is clean. Steam pressures from atmospheric up to 150 lb. per sq. in. have been used. Since a pipe treated in this manner must be free to expand throughout its length, the process apparently has a somewhat limited application.

This scheme was originated by C. W. Poulson, chief engineer of the Equitable Building in New York City. To date, about 2500 ft. of pipe have been cleaned in lengths varying from 250 to 500 ft.

Long Distance Transportation of Water

An Outline of the Main Factors to Be Considered, Particularly in the Solution of This Phase of the Water Supply Problem in the Semi-Arid Southwest

By E. A. BAYLEY

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MANY important elements must be taken into consideration in making the preliminary investigations for the transportation of large quantities of water over long distances by means of an aqueduct system. Among these, may be mentioned.

1. The determination of the definite point of intake for the aqueduct and its location with relation to any initial storage which may be provided.
2. The location of its terminus and the minimum terminal storage required.
3. The character of the country which the aqueduct is to traverse.
4. The type of aqueduct suitable for the country through which it is to be built, and the material to be used in its construction.
5. The quantity of water to be transported.
6. Whether or not pumping along the route will be necessary.
7. The possibility of generating power along the aqueduct route.
8. The most suitable rates of gradient for its several parts.
9. The estimate of construction costs.

In the case of several routes being available, a comparison of the construction and operating costs of one route with another must be made, in order that the most economical one may be selected.

Location of Point of Intake.—In locating a definite point of intake for an aqueduct, there are two major factors —topographic and hydrographic—which enter into the problem. The topographic factor includes the elevation of the river itself, the possibilities for reservoir sites and the elevations of these sites with respect to the proposed aqueduct. The suitability of the intake for the elimination of silt and other suspended matter such as brush and trees often carried in flood flow, is also a topographic matter of importance.

A proper consideration of the hydrographic features shows that the intake should be placed where there is a certainty of obtaining an ample quantity of water at all times. If taken too far upstream, the requisite supply might not be available due to the small contributing drainage area above. On the other hand, if taken too far downstream, evaporation and seepage losses might increase at a greater rate than the gain from tributaries. This would reduce the stream flow and possibly affect the supply available.

Both the topographic and hydrographic features were given careful attention in locating the point of intake of the Los Angeles Owens River Aqueduct. From a topographic standpoint, the aqueduct had to be so located that water could be discharged into the city's Haiwee Reservoir on the divide between the Owens Lake Basin and the arm of the Mojave Desert known as Indian Wells Valley. From a hydrographic standpoint, it was deemed advisable to place the grade of the aqueduct sufficiently low that a gravity flow from some very large springs, known as Black Rock Springs, could enter the canal. These springs are located about 60 miles beyond the Haiwee Reservoir, and at a slightly higher elevation. With the grade fixed by the relative elevations of Haiwee and Black Rock Springs, the aqueduct location was prolonged northerly to an intersection with the Owens River, where a suitable intake was constructed.

The Colorado River in its lower reaches is situated at an elevation not greatly above sea level. Many cities of the coastal plain of Southern California to be supplied with water from this source, are relatively higher in elevation. Therefore, any intake in this portion of the river would require an aqueduct of a non-gravity type, that is, one through which the water is pumped over at least a part of its length. If a gravity aqueduct from the Colorado River is constructed, the intake would have to be placed far up the river in order to deliver water to the coastal cities.

Storage Requirements.—A liberal amount of terminal reservoir storage is needed when an aqueduct system is operating at its maximum capacity. The storage required by the city of Los Angeles to operate the Owens River Aqueduct system for the year 1928, is given as an example of relative amounts.

During that year, in caring for its domestic demand, approximately 7 per cent of the annual quantity of water transported, was stored during the winter months for use during the following summer. For irrigation in the San Fernando Valley within the city limits, about 40 per cent of the annual quantity used for this purpose had to be stored. In hillside home areas, roughly 17 per cent of the annual demand was likewise taken from storage. During the whole year, the total terminal storage required to provide for the combined domestic and irrigation demands on the Owens Valley Aqueduct system, was approximately 19 per cent of the entire quantity of water transported.

Storage facilities should be located as near the territory to be served as is practicable, and if possible at a higher elevation.

Character of Country to Be Traversed.—In order to determine the nature of the country through which an aqueduct is to pass, it is necessary to have accurate topographic information concerning the territory. If topographic maps of the Geological Survey are available, it is possible to get at once a general idea of the topography of the country to be traversed. If such maps are not yet made, it becomes necessary to make a detailed survey of the area. This topographic survey usually consists of the making of contour maps, showing a contour interval sufficient for the purpose at hand. These can be made either by the transit and stadia method or by the plane table method. In either method, a system of horizontal control must be installed prior to the actual mapping of the ground. If the transit and stadia method is used, the system of control is usually a chained traverse; while if the plane table method is adopted, triangulation is generally best. The plane table method is used by the United States Geological Survey in all of its mapping for the topographic atlas of the United States, and is also the one used on the Colorado River Aqueduct Project. The information gained from the contour maps, supplemented by field examinations, discloses the several kinds of structures of which the aqueduct will have to be constructed. Mountainous areas indicate that tunnels must be used; conduits or canals are the most suitable for level, plain or desert country; and deep canyons require inverted siphons as a part of the system.

In the case of the Colorado River Aqueduct Project, careful studies of the territory involved show that a complex situation of desert, mountain and valley topography exists. Much of the country through which construction work will have to be carried, is vast desert waste land scattered with rugged ranges acting as barriers. There is, however, a stretch of territory near the western end of the proposed aqueduct which is highly cultivated, where orange groves and vineyards abound. This illustrates that there are many complicated problems which must be solved in the lo-

cating of an aqueduct with relation to the varied topographic conditions.

Type of Aqueduct Construction.—Aqueducts have been constructed of stone, wood, brick, concrete and other materials. The most recently constructed aqueducts have been built mainly of concrete. Where valleys intervene, either reinforced concrete or steel inverted siphons have been used. Tunnels are usually lined with concrete, though this lining is sometimes omitted where the rock is exceptionally firm.

The most suitable type of aqueduct for desert country which is subject to cloudbursts, is probably one that is covered, except in the case of inverted siphons, constructed wholly of concrete, and buried throughout its length. This permits torrential surface flows to pass over the aqueduct without damage to its structure. Modern practice varies in the case of inverted siphons of steel or iron. Some have been buried throughout their length, while others have been supported on piers where they may be inspected and repaired from time to time. The latter case is equally satisfactory with respect to cloudburst conditions.

In the case of Catskill Aqueduct for the New York water supply, a type known as "cut and cover" was built. It is constructed of concrete, horseshoe in shape, and only partially buried. The excavated material was used to make the embankment over the structure. While this type of aqueduct is no doubt suitable for Eastern conditions, it is obvious that on our Western deserts, where no definite stream channels exist, and any section of the desert may be subject to extreme erosion from torrential floods, the better practice would be to bury the aqueduct throughout.

Quantity of Water Transported.—In designing an aqueduct to carry an exceptionally large quantity of water, it is necessary to exercise unusual care in determining its correct cross-sectional dimensions. It must have the best hydraulic properties consistent with good constructional design. The construction quantities per unit of length should be a minimum and still obtain an enduring structure. The subject of hydraulic design must be carefully considered in order that the aqueduct when completed and placed in operation will have the required capacity. When properly designed, the flow should closely approximate the theoretical flow indicated by the formulas used.

The amount of water which can be transported in an aqueduct, is dependent upon its velocity. There are various formulas for the computation of the velocity of flow in conduits, canals, tunnels, inverted siphons, flumes, force mains and penstocks such as make up a complete aqueduct system. These formulas are largely based upon experimental data found to exist in other similar structures. Formulas derived by Ganguillet and Kutter, Williams and Hazen, Scobey and others, give satisfactory results. Likewise, good results can be obtained from other exponential formulas derived from the known flows of constructed aqueducts similar to the one proposed.

In the design of the Los Angeles Aqueduct from the Owens River, the Board of Consulting Engineers who reviewed the plans in December, 1906, suggester the use of the Kutter formula with a value of "n"=0.014 for the design of covered concrete conduits, and the Chezy formula with a value of "C" = 90 for riveted steel pipe lines. Since that time, a number of large conduits and pipe lines, notably those of the Catskill and our own Los Angeles Aqueduct, have been built, and numerous measurements of the actual flow in such conduits have been made. Careful examination of these experiments lead to the valuable conclusions as to the best formulas to adopt in the design of any large aqueduct. In applying such formulas, engineers generally use conservative factors. However, the use of factors which are too conservative, in order to insure the rated capacity, may result in far greater cost than necessary.

Necessity for Pumping.—The ideal method of transporting water long distances is by means of a gravity aqueduct, or one which is constructed on a continuous down-grade from its intake to its terminal point. However, in cases where a gravity aqueduct cannot be built within economic limits of cost, pumping must be resorted to, and a non-gravity aqueduct constructed. In such a case, in order to pump the water economically, ample power available at a low cost is indispensable.

The idea of a gravity aqueduct has an appeal to the popular mind, due largely to prejudice brought down from the past. When pumping plants were small and machinery unreliable, there was a lack of dependability in pumping projects. Additional sums were then properly spent to assure a supply by means of gravity, as pumping methods proved unsatisfactory. All this is now changed. This is a mechanical age, and machines have been perfected so they are about the most dependable things in existence. A pump is little more subject to derangement than a tunnel.

Generating Power.—In the building of any aqueduct, gravity or non-gravity, topographic conditions along the route sometimes make feasible the generation of power. The value of power, increasing year by year, justifies a very careful study of the location of an aqueduct to determine this possibility, and may warrant an additional expenditure to obtain it. If the estimated cost of construction, then, is found to be less than the warranted expenditure, the power plants should be built and operated.

In the building of Owens River Aqueduct, the City of Los Angeles took advantage of the difference in elevation between the Fairmont Reservoir and the Lower San Fernando Reservoir for the generation of power. The city has built three large power plants along this section of the aqueduct. These have been operated for a number of years and the net revenue derived from them has more than warranted their construction.

Along the proposed Colorado River Aqueduct, there is also a possibility of generating some return power near its western terminus. Whether this possibility is economically feasible or not depends upon the result of studies now in progress by the Department of Water and Power of this city.

Most Suitable Gradient.—The cost of constructing any aqueduct is largely dependent upon the hydraulic grade used. Any change in gradient will have its effect on the velocity of the water in the conduit. By flattening the slope, the velocity will be reduced and the cross sectional dimensions must be correspondingly increased in order that the carrying capacity will be unaltered. Conversely, by steepening the grade, the velocity will be increased, and the cross-sectional area can be similarly reduced.

When the points of intake and delivery are fixed, it is often possible to obtain the minimum total cost by balancing the gradients between the several types of structures which vary greatly in cost. In this case, the minimum cost is obtained when the gradients are so established that a change in any one affecting its cost will produce an equal and opposite change in the cost of any other.

It is usually considered sufficiently accurate to balance grades graphically. Curves are plotted showing costs in relation to head, for the various sections of the aqueduct under construction. If tangents are drawn to these curves in such a way that the sum of the heads to be consumed is equal to the total available head, the sum of the costs will be a minimum. Dividing the resulting head for each section by its linear length will give the proper gradient for that section. The results are, of course, subject to limitations in that balancing the gradients must not affect the aqueduct location sufficiently to place it in ground more difficult of construction.

In the location of the Los Angeles Owens Valley Aqueduct, the method of balancing grades outlined was used with considerable success. Between Haiwee and Fairmont, a distance of 135 miles, the saving shown between the estimated cost of the aqueduct having balanced grades and that of one without balanced grades, was considerable.

Where an aqueduct is designed with pumping plants along the line, any change in the hydraulic gradient will effect a change in the head pumped against, and consequently will alter the cost of operating the pumps. The cost of pumping is also dependent upon the demand for water by the consumers.

Therefore, in such a non-gravity aqueduct, the cost of pumping must be balanced against interest and other charges on the cost of construction. This balancing of operating costs against interest and other charges for construction must be studied carefully in order to arrive at the most economical combination of grades and lifts. Due to these variable factors, the estimated capital investment in a non-gravity aqueduct may vary within wide limits.

Estimating Construction Costs.—In long distance transportation of water, the product transported is generally delivered to the user at a price which, if computed on the basis of a price per ton, would be but a few cents as against many dollars for all other commodities. In order to accomplish this remarkable feat, the cost of construction to be carefully estimated, and in actual construction, must be kept within reasonable bounds. A difficulty is found in making comparisons, in the lack of finished works of large size, which can be used for guides as to costs. This is particularly so for projects built within the last decade, when labor and material cost have advanced so rapidly. Study must be made of the laws enacted within recent years bearing on compensation and hours of labor, camp sanitation, safety and other similar matters, all of which must be considered in making estimates. The greater use of mechanical equipment offsets to some extent the higher cost of labor, and there must be careful balancing between the greater use of machinery and manual labor. In preparing an estimate, it becomes necessary to analyze each piece of construction and develop costs step by step, taking care that no essential element is omitted. Certain assumptions must be made, and there the designer has to draw upon all available information and decide according to his best judgment as to what plan of operation should be used.

In considering the relative costs of conduit and tunnel, it will be found in ordinary construction for equal capacities, that the cost of tunnel will be about double that of conduit. In general, the items making the total cost may be expressed in terms of labor, material and equipment, freight and hauling, energy and general expenses such as roads and trails, water supply for construction, camp sanitation, hospital and first aid and communication.

Acknowledgment.—The foregoing is an abstract of a paper presented before the Water Supply Section in the Short Course in Public Administration held June 17 to 21 at the University of Southern California.

Household Leakage.—An inspection by employees of the Water Board of Cambridge, Mass., during the past year located the following leaks:

On basins	171
On bath tubs	142
On set tubs	78
On faucets	2,198
On toilets	1,402

Gate Valves and Fire Hydrants

Notes on Their Maintenance and Operation

By CARL A. HECHMER
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IT IS surprising, especially in small towns and villages, how little attention is given the maintenance of gate valves and fire hydrants on their water systems. The need of good engineering advice and design is recognized and is compulsory in almost every state. Practically every state health department has a law compelling the submission of plans for approval before a water system can be built. The question of good materials is also generally given the utmost consideration and the best valves and hydrants obtainable, in the judgment of those in charge, are purchased and put into the water system. In many instances they are promptly forgotten until an emergency arises and quick, sure operation is necessary. Unless valves and hydrants are given regular attention and properly maintained, the water works superintendent has no assurance that they will function properly. This fact applies to any make of valve or hydrant or to any other mechanical device or piece of machinery. Unfairly the failure reflects on the designing engineer or the manufacturer of the material and the local department is given a clean bill of health.

Valves.—All valves on a water distribution system should be inspected once each year. This is the minimum requirement of the Fire Underwriters' Association. However, semi-annual inspection is advisable, if finances will allow it. Not only will the mechanical condition of the valve be assured, but valve boxes covered by paving material or earth will be located and reset ready for immediate operation in emergency. This is especially true in rural and suburban sections with a large percentage of unpaved streets. When a large leak occurs, excitement prevails and considerable time may be lost locating a valve box. Occasionally a large stone or stones are found down in valve boxes and these conditions are revealed on inspection and removed. In case the valve has to be dug up, uncovering the valve, it is advisable to install new packing in the packing gland which will prevent digging it up for a repacking for a long time. Always repack a valve when it is uncovered for any repairs. Packing is cheap and easily installed while the valve is exposed. To dig up a valve just to stop a packing leak is an expensive operation. Inspection also brings out valves which were carelessly or accidently left closed. Any water distribution system is weakened by gate valves being closed when they should be open.

How a Valve Inspection Should Be Made.—In addition to the box inspection, a valve inspection should proceed as follows: First set the valve key on the valve nut preparatory to turning the stem. Pour a small quantity of kerosene or diluted automobile crankcase drainings down the valve key stem. The oil will run down the key to the operating nut, thence to the valve stem and lubricate the valve stem against the packing gland. Finding its way into the packing gland, the packing will be softened and revived. Then operate the valve up and down several times, bringing the gate down into the groove hard each time and then opening the valve about one-quarter way. Valve troubles, preventing complete shut down, are usually caused by the accumulation of sediment under the seat. Each time the gate is pushed down into the groove a small portion of this sediment is pushed out the sides. The high velocity of the water through the partly opened valve removes what is pushed out and the operation is repeated until the groove is sufficiently cleaned to allow the gate to seat properly. This procedure is especially recommended when valves fail to hold when attempting a shut down. Of course, if the groove is filled with large stones or jointing material, the valve must be dug up and taken apart for repairs. The writer once operated a 16-in. valve up and down thirty times and secured a perfectly tight shut down. The valve had not been operated for a long time, having been declared worn out, since it always allowed a large volume of water to pass with the gate turned down hard with levers on the key.

In operating the valve a check should be made of the number of turns on the stem. Generally for the same size and make of valve the number of turns to close or open the valve completely is the same and a check can be made to see if the stem is bent preventing the valve from completely closing or opening. Either condition should be corrected, as partly open valves weaken the system and, obviously, partly closed valves will not shut off the water.

If the valve stem can be turned around and around with no apparent effect on the gate, the stem is broken and must be repaired.

Geared valves, usually set in manholes, must be given special attention on inspection. The gears should be cleaned with a wire brush and greased with a light clinging grease. The stuffing box should, of course, be examined and by the by-pass valve should receive the same attention as the smaller valves on the distribution system.

Fire Hydrants.—Proper care in the installation of a fire hydrant is necessary and makes maintenance less expensive. Proper drainage of the hydrant barrel after the main valve is closed is essential to prevent freezing of the hydrant in northern climates. The best method is to provide a bed of crushed stone or gravel around the bottom of the hydrant. The amount of stone necessary is dependent on the nature of the soil. In loose sandy soils a much smaller drainage bed can be provided than in a clay soil that absorbs water very slowly. A safe margin is to provide sufficient area to allow the drainage of an amount of water equal to twice the contents of the hydrant barrel. Connections are often made direct from the hydrant drain valve to the sewer. However, there are two serious objections, first the cost and second the direct connection between a sewerage system and a domestic water supply, even though the possibility of contamination reaching the water in the mains is remote. Generally water mains are laid on one side of the street and sewers on the other. Hydrants are installed at the curb on the same side as the water mains to shorten the length of the lead. To connect each hydrant drain across the street to the sewer would prove much more expensive than providing a stone drainage bed.

Fire hydrants must be inspected at least twice each year, in the spring and fall. Four inspections annually should be made, if possible, and this number of inspections is advocated by the Fire Underwriters' Association. In high value districts, weekly inspections are often made during extremely cold weather. Arrangements should be made between the water department, the fire department and any other possible users of hydrants to report to the water department immediately after using a hydrant during freezing weather and an immediate inspection made to insure the good condition of the hydrant. Use of hydrants by private individuals or contractors should be allowed only by special permit and the daily charge made high enough to permit daily inspection during freezing weather. During mild weather the inspection charge can be reduced as weekly inspections are sufficient.

Valuable data may be secured by the fire hydrant inspection by measuring the static pressure, the residual pressure with one nozzle open and the flow of water from the hydrant. Weak points on the distribution system can thus be determined and improvements due to new installation readily noted. System weakness due to unknown closed valves is also discovered and can be corrected.

Procedure for Making a Hydrant Inspection.—The following procedure is suggested for making a hydrant inspection:

First make a physical examination of the hydrant, noting the condition of the operating nut, the nozzle caps and chains and the general appearance of the hydrant. Then listen for leakage with an aquaphone placed on the operating nut. Then with the nozzle caps on tight open the hydrant valve. If static pressure readings are to be taken replace one of the nozzle caps with one connected to a pressure gauge. Note if all the nozzles are tight in the hydrant and whether the drain valve has closed properly. If the drain valve has not closed water will appear around the barrel of the hydrant on the outside. Then close the main hydrant valve and take off one of the nozzle caps. Observe the rate of drainage of the barrel to determine whether any obstruction has entered the drain valve. To clean the drain valve replace the nozzle cap and crack the main valve. As it requires about three full turns open on the main valve to completely close the drain valve on most makes of fire hydrants, the latter is still open on two turns. The full pressure of the water in the hydrant generally will push out any obstruction in the drain hole and the jet effect of the water through the hole will cut away the stone or earth which has packed around the outside. This simple remedy will eliminate the necessity of digging up the hydrant in most cases to correct drainage troubles.

With one nozzle cap off open the hydrant and thoroughly flush out the water in the lead. At this time the observation of residual pressure and rate of flow should be made. Then close down the hydrant slowly. If the hydrant fails to close off entirely, the trouble is probably being caused by an obstruction under the main valve. Do not put extra leverage on the hydrant wrench, but open the hydrant up again and then close it, repeating the operation several times. Do not attempt to close down beyond the point where the obstruction prevents the main valve from seating properly, as the obstruction will become embedded in the main valve and cannot be flushed off, or the valve seat will be damaged. Both valve and valve seat are damaged by attempts to force closing against obstructions. Foreign matter can generally be dislodged by flushing and it is then not necessary to dismantle the hydrant.

After the hydrant is closed and the rate of drainage checked, the stem should be oiled and the nozzles greased with a graphite grease. This kind of grease will not wash off and it prevents the nozzle caps from sticking.

Inspection Records.—Record of the inspection should be kept on a field sheet. The location of the hydrants to be inspected can be entered on the sheet in the office. These will allow correct routing and prevent skipping any hydrants. The information on the field inspection sheets can then be transferred to a permanent record card in the office. A card should be in the file for each hydrant, stating the size, make of hydrant and information regarding pressure at the hydrant. The date of each inspection should be entered on the card together with the observed pressures and rate of flow. Necessary repairs and their costs can also be recorded on the card and a history of each individual hydrant is easily obtained.

For quick reference the following is suggested: Use a map of the water system mounted on wall board with a push pin to denote the location of each hydrant. The color of the pin can show the condition of the hydrant as reported daily by the hydrant inspectors and the repair foreman. Use a blue pin for a hydrant in good condition, a black pin for a hydrant in need of minor repairs but not out of service, and a red pin for a hydrant out of service. Then when an inspector reports a hydrant out of service it is possible to tell at a glance whether the hydrants around it are in good condition. If several makes of hydrants are in use it is an advantage to know the make of hydrant before sending out a repair gang so the proper parts can be carried along. By using a small round colored disc under each push pin it is possible to determine at a glance the make of each hydrant, a different color being used for each make of hydrant.

For the sake of appearance and to protect the metal, hydrants, should be painted once every two years and if possible annually. Use a good grade of paint and care should be exercised to prevent getting paint on the nozzle threads or operating nut. The grooves on the nozzle caps which hold the chain links must be thoroughly brushed out as excess paint will harden and retard the fire department in removing the nozzle caps to connect fire hose.

Acknowledgment—The foregoing is taken from the July Journal of the American Water Works Association.

National Parks Cover 12,113 Miles.—In the last year the area of the national park system has been enlarged to 12,113 square miles, an increase of nearly 200 square miles, through the addition of lands to existing parks and the establishment of new ones, according to the records of the Department of the Interior. The greater portion of the new territory was added through legislation enacted at the second session of the Seventieth Congress. An area of about three square miles of spectacular scenic beauty was recently added to the Acadia National Park on the coast of Maine through the acceptance by the Secretary of the Interior of deeds covering this land.

Financing the Operation of Sewage Disposal Plants

A Discussion of Sewer Service Charge or Sewer Rental Charges Plans

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IT is possible that every plant operator and city official in cities having a sewage disposal plant, is interested in its proper operation, even though at times from outward appearances at least, his interest may seem to be dormant. He, she or they, as the case may be, may be ever so interested, and still be unable to do anything about it. While it is true that there is at present a decidedly awakened "sanitary conscience" on the part of the public generally in connection with municipal sanitation, the fact remains that taken by and large the sewage disposal plants throughout the country hold a position somewhat like that of an unwelcome orphaned child. Some acquaintance with them is necessary, but it is not to be cultivated. The country is literally covered with disposal plants not giving results easily obtained with just a reasonable amount of maintenance and operation. In many cases, the stream or water courses into which the effluents from the plants discharge, is in no better condition than before the plant was installed. The expenditures for sewage disposal plants throughout the country run into many millions of dollars, which means a tremendous economic waste if they are not properly maintained and operated. There is probably no other line of endeavor either public or private where vast sums are expended, and then allowed to go without attention or maintenance, let alone operation. What is the matter with sewage disposal?

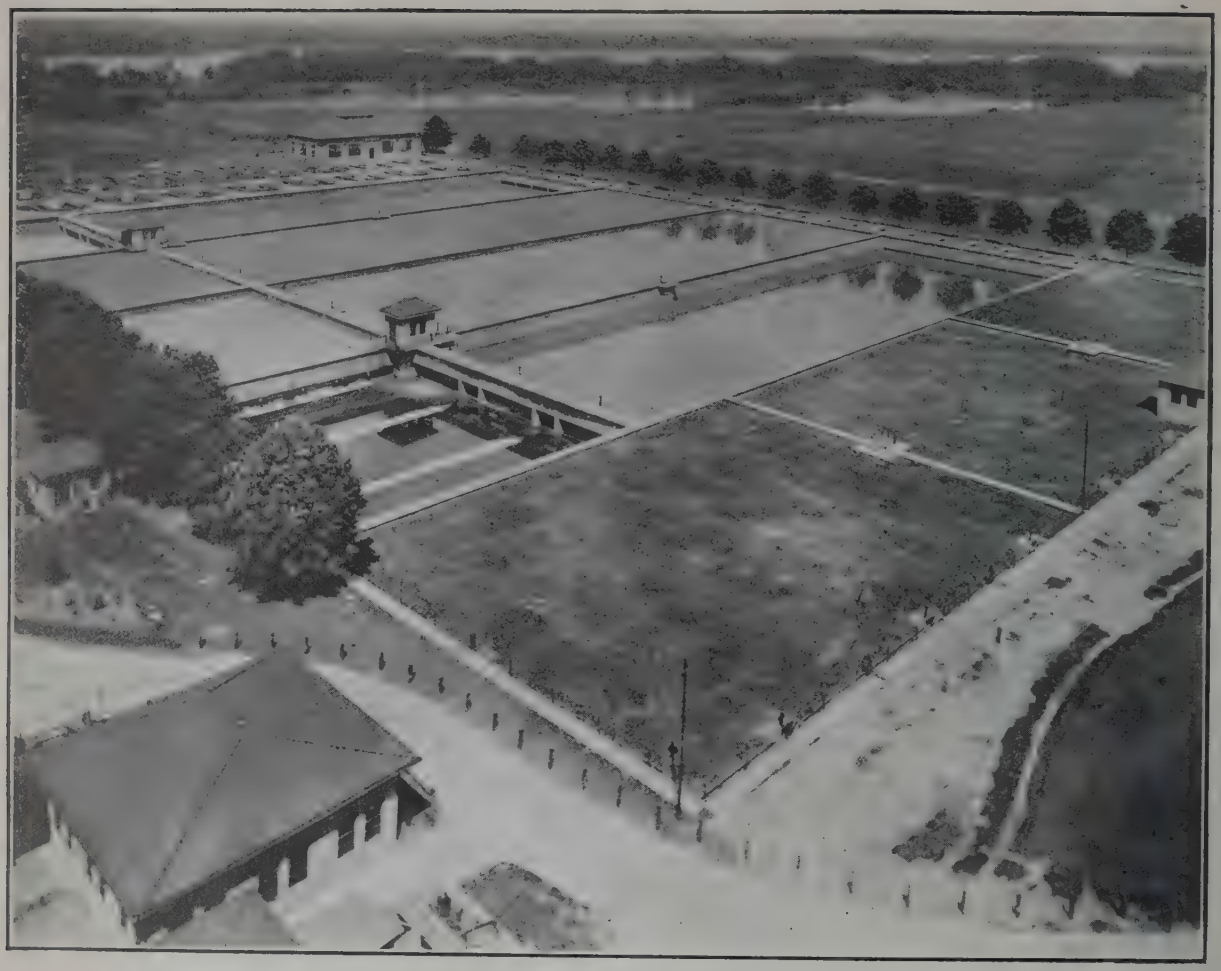
Contributing Causes for Neglect of Sewage Disposal Works.—There are several contributing causes for the general feeling of apathy toward the average disposal plant. Quite a number have been installed under orders from state boards of health, in order to protect water supplies or prevent nuisances. Others have been built on account of threatened or actual damage suits filed by owners over or through whose land the effluent is discharged. In either of these cases the plant is forced upon the city, and is not built on account of any real desire on the city's part to clean up pollution or nuisance caused by its wastes. Such conditions do not create a sympathetic feeling at least on the part of the public at large. It is interesting to note here, that in practically every case where the public interest is aroused, even though perhaps selfishly, excellent operation and maintenance is usually obtained. Reference is made to cities where lack of proper operation would effect those same cities, such as the ones along the Great Lakes, where effluents discharge into waters used for water supply; where sewer outlets are upstream from water intakes; or where effluents flow through the city, etc. Improper design is perhaps another contributing cause for neglect of plants. While sewage disposal is one branch of sanitary science that calls for the highest skill and knowledge to obtain proper design for each problem, and undoubtedly a large number of plants do not reflect engineering excellence, it is doubtful if poor design can be justly used as an excuse for poor or no operation. It is probable that the great majority of plants with improper design, could with technical guidance in operation, be made to function at least satisfactorily. This of course excludes plants that are heavily overloaded, or that have gotten into such a state of repair that operation is impossible.

Lack of Funds Handicap to Proper Operation.—The factors mentioned above as effecting operation of sewage disposal plants adversely are only contributory. There is one outstanding and in fact universal handicap to proper operation, i. e., lack of funds. The plants themselves are built with funds raised by bond issues or by special assessments, but generally speaking no arrangements are made for financing the maintenance and operation. Of course, every city has its "General Fund" to fall back upon, but it is the rule rather than the exception that this fund is already carrying all the burden possible. In some states the amount that can be raised by general taxation is limited by statute, and back of that is the usual desire on the part of the city officials to reduce rather than increase taxes, a very worthy and proper desire when it can be done.

The urban population is increasing steadily and practically and all cities are increasing in size each year. Additional demands are constantly being made for more and better municipal service, such as water, light, garbage removal, sewerage, etc. It is indeed a fortunate group of city officials that can keep taxes from raising, let alone reduce them, assuming of course that extravagance and waste is not practiced. Therefore, it is perhaps natural that the need of funds for operation of sewage disposal plants has been shoved into the background. It is the purpose of this paper to discuss a means of solving this financial embarrassment in which the sewage disposal industry finds itself.

Financing Sewer Rental Charges.—The plan has been styled "Sewer Service Charges" or "Sewer Rental Charges" and is in actual operation in at least two states, namely Ohio and Michigan, and is being considered seriously by health authorities in many of the other states. The plan is made possible by an enactment of the state legislature, authorizing cities having sewerage, sewage disposal plants, etc., or contemplating acquiring or building any or all of such improvements, to levy a service charge against all property connected to the system. In the two states mentioned, the statutes give the governmental authorities great power in assessing and collecting these service charges or rentals. Attention is called here to the two statutes mentioned, copies of which are given elsewhere in this article. The statutes authorize the governing bodies of municipalities to assess a sewer service or rental charge, and gives the power to collect such charges in the same manner as other taxes. The assessment can be levied along with the other taxes if desired. The Michigan statute has been amended several times, the copy given herewith being the present law. It goes somewhat further than the Ohio law, in that it authorizes the issuance of bonds for construction purposes in excess of the amount authorized by statute and includes garbage as well as sewage. In other words, there is no limit for such issues, but the bonds are not a direct obligation on the city. The bonds would be similar in character to the "Utility Bonds" that are authorized in some states. With such bonds, the property mortgaged is the sewers and disposal plant only. The purpose of this law no doubt was to give financing power to cities already bonded to the legal limit, and to small cities where the amount that could be raised under statute would be insufficient. It is questionable whether it would not be better to authorize additional bonding power for sewers and sewage disposal, issuing general obligation bonds, as their market value would be higher than the so-called "Utility Bonds," and thereby give a more economical means of financing. At any rate, quite a number of cities in each of the above mentioned states have enacted ordinances establishing schedules or rental charges, and have or will have funds to properly operate and maintain their disposal plants.

It seems that there can be little question about the desirability of having laws passed in all states, making the charging of sewer rentals possible.



Tanks and Sludge Beds at Back River Plant, Baltimore, Md.

Plants that are now neglected because of lack of funds, could be given proper attention. It is also probable that sewage disposal and general sanitation will receive more consideration, as the importance and need of such improvements will be constantly brought to the attention of the public, by the potent means of a bill for rental. The system of charging for service rendered will put sewage disposal, garbage collection and disposal, and other sanitary measures on the same general plane of respectability as other public utilities.

Rental Details Left to Governing Body.—The Sewer Rental laws in Ohio and Michigan leave the details of the rental charges to the governing body in each particular case, with the exception of privately owned systems in Michigan, which is wise. Rental charges for privately owned systems in Michigan are to be determined by the Public Utility Commission. The question of what rentals to charge is one that will require considerable thought and study in each particular case. Most of the charges that have been established so far are based on the amount of water consumption. This is probably a fair basis in small cities where the sewage is strictly domestic. In larger cities, especially those having a number of industrial plants, the situation is different. Here some industries may have a large water consumption and still contribute a small amount of sewage, also two industries may contribute the same amount of sewage with the sewage from one being four or five times stronger than the other. Also, certain industrial wastes may have a very destructive effect on sewers and operation of the disposal plant due to chemicals. It is possible that the use of water consumption data, tempered by a study of the bio-chemical oxygen demand of the different industrial wastes will give a fair basis for establishing rentals. As stated, the question of proper rentals will require considerable study, as most cities are urging industries to come to them, and great care will have to be exercised to avoid discrimination between the "wet and the dry" industries, although it is probably just that a wet industry contributing a difficult sewage to purify should include an extra item in production costs to cover its disposal. With properly adjusted rates it will be possible to obtain enough revenue to properly operate and maintain any disposal plant, without imposing a hardship on any one. In fact, the rentals required, compared with other utilities, will be in most cases ridiculously small.

Operators or city officials can render a real service to their cities, and to health and sanitation in general by using their influence in the passage of a sewer rental law in their respective states. There should be no legal limits to bonding power of any city for the construction of necessary sanitary works, and the raising of funds for their maintenance and operation.

MICHIGAN STATUTE

STATE OF MICHIGAN, 55TH LEGISLATURE
REGULAR SESSION OF 1929
Senate Bill No. 329 (File No. 350)
Introduced by Senator Woodruff
SENATE ENROLLED ACT No. 99
Ordered to be known as the Dykstra Act

An act to amend the title and sections one, two, three, four, five, six, seven, eight, nine and ten of act number three hundred twenty of the Public acts of nineteen hundred twenty-seven, entitled "An act authorizing cities and villages to provide a sanitary means of disposing of the sewage and night soil thereof; to charge owners or occupants of premises therefor; to raise money and issue bonds to erect and maintain sewage disposal plants, and to repeal act number two of Extra Session of nineteen hundred

twenty-six, and any other acts or parts of acts inconsistent herewith," and to add three new sections to said act to be known as sections twelve, thirteen and fourteen.

The People of the State of Michigan enact:

Section 1. The title and sections one, two, three, four, five, six, seven, eight, nine and ten of act number three hundred twenty of the Public Acts of nineteen hundred twenty-seven, entitled "An act authorizing cities and villages to provide a sanitary means of disposing of the sewage and night soil thereof; to charge owners or occupants of premises therefor; to raise money and issue bonds to erect and maintain sewage disposal plants, and to repeal act number two of Extra Session of nineteen hundred twenty-six, and any other acts or parts of acts inconsistent herewith," are hereby amended, and three new sections are hereby added to said act, said amended title and sections and added sections to read as follows:

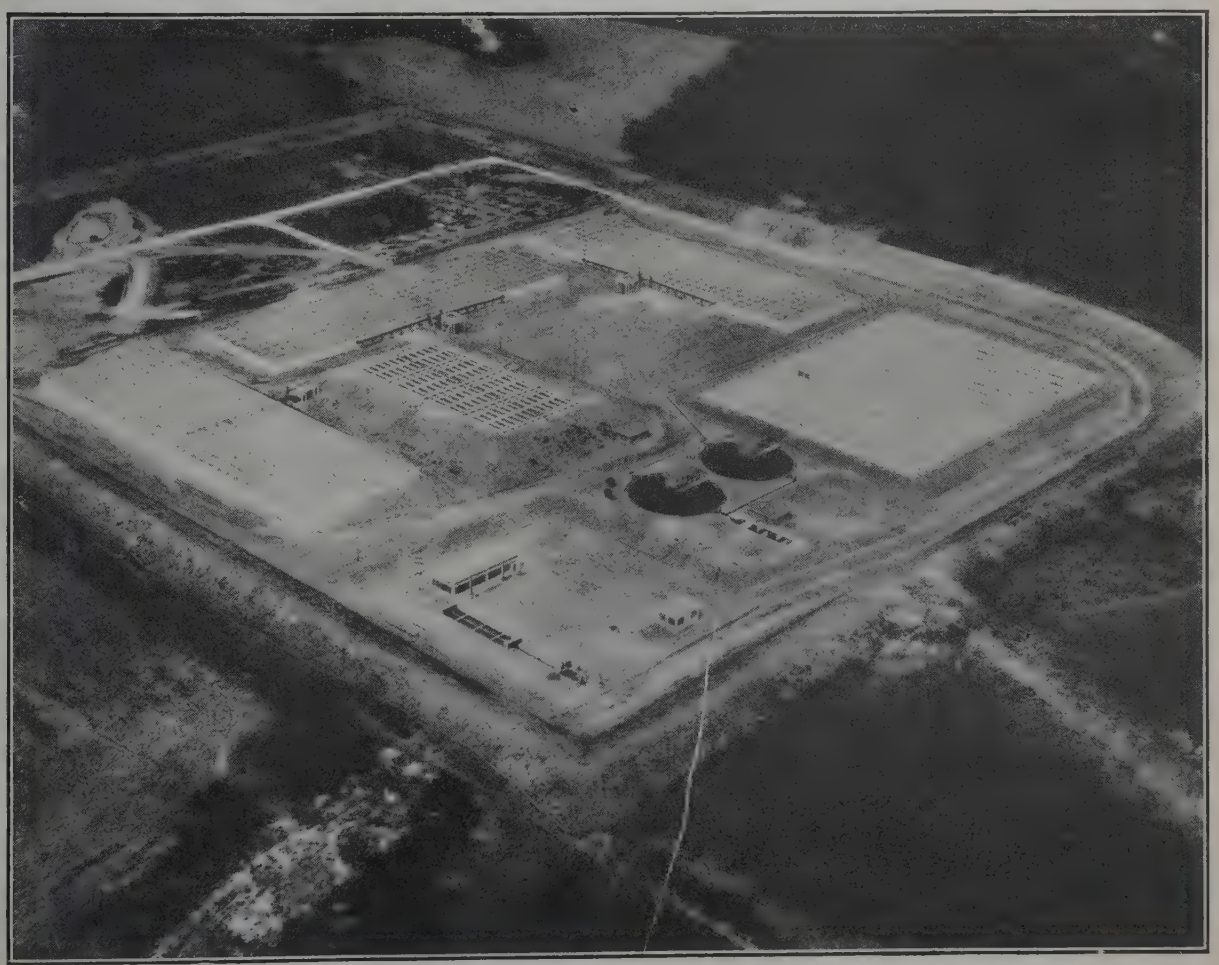
TITLE

An act authorizing counties, cities and villages, either individually or jointly by agreement, to provide a sanitary means of disposing of the garbage, sewage and night soil thereof; to charge owners or occupants of premises therefor; to borrow money and issue bonds to own, acquire, construct, equip, operate and maintain intercepting sewers and sewage disposal plants, and garbage disposal plants, and to repeal act number two of the Extra Session of nineteen hundred twenty-six, and any other acts or parts of acts inconsistent herewith.

Section 1. Any county, city or village in this State, either individually or jointly by agreement, is hereby authorized to own, acquire, construct, equip, operate and maintain either within or without the statutory or corporate limits of such governmental agencies or municipalities, intercepting sewers, including pumping stations, a plant or plants for the treatment, purification and disposal in a sanitary manner, approved by the State Department of Health, of the liquid and solid wastes, sewage and night soil and garbage of such governmental agencies and municipalities. They shall have authority to acquire by gift, grant, purchase or condemnation necessary lands therefor, either within without the statutory or corporate limits of such governmental agencies or municipalities. For the purpose of acquiring property for the uses herein mentioned such governmental agencies or municipalities may invoke and shall have all the rights, powers and privileges granted to "public corporations" under the provisions of act number one hundred forty-nine of the Public Acts of nineteen hundred eleven, being sections three hundred fifty-three to three hundred seventy-three inclusive of the Compiled Laws of nineteen hundred fifteen as amended, and which shall be in addition to any powers granted by such governmental agencies by statute or municipalities by their charters.

Section. 2. Such intercepting sewers, pumping stations, sewage disposal plant and system, and garbage disposal plant and system, shall be considered a public utility within the meaning of any constitutional or statutory provision for the purpose of acquiring, purchasing, owning, operating, constructing, equipping and maintaining such intercepting sewers, pumping stations, sewage disposal plant and system, and garbage disposal plant and system. Governmental agencies or municipalities may issue faith and credit bonds or mortgage bonds therefor beyond the general limits of the bonded indebtedness prescribed by law except as hereinafter provided. Such mortgage bonds as provided in this section shall not impose any general liability upon the governmental agencies or municipalities but shall be secured only on the property and revenues as hereinafter provided of such utility including a franchise, stating the terms upon which, in case of foreclosure, the purchaser may operate the same, which franchise shall in no case extend for a longer period than twenty years from the date of the sale thereof on foreclosure. Such mortgage bonds shall be sold for not less than par, bear interest at a rate not to exceed six per cent per annum, and the total amount thereof shall not exceed sixty per cent of the original cost of the utility except as hereinafter provided. No bonds shall be issued as general obligations of the governmental agencies or municipalities except upon a three-fifths affirmative vote of the qualified electors of such governmental agencies or municipalities and except as hereinafter provided, not in excess of three per cent of the assessed valuation of the real and personal property of such governmental agencies or municipalities as shown by the last preceding tax roll. No bonds shall be issued as faith and credit bonds or mortgaged bonds of the utility except upon a three-fifths affirmative vote of the legislative body of such governmental agency or municipality.

Section 3. The legislative body of any such governmental agency or municipality or the respective legislative bodies of such governmental agencies and municipalities, who may have agreed to jointly own and operate intercepting sewers or sewage treatment plants, may create a separate board or may designate certain officials of the governmental agencies or municipalities, to have the supervision and control of such intercepting sewers or sewage and garbage disposal plants. The legislative body, respective legislative bodies, or such board may make all necessary rules and regulations governing the use, operation, and control thereof. The legislative body or respective legislative bodies may establish just and equitable rates or charges to be paid to them for the use of such disposal plant and system by each person, firm or corporation whose premises are served thereby. If the service charge so established is not paid when due, such sum may be recovered by the governmental agencies or municipalities in an action of assumpsit, or it may be certified to the tax assessor and assessed against the premises served, and collected or returned in the same manner as other county or municipal taxes are certified, assessed, collected and returned.



Aerial Photograph of Sewage Disposal Plant, Fort Worth, Tex.

Section. 4. Bonds which are issued and secured by a mortgage on the utility as hereinbefore provided shall not be a general obligation of the governmental agencies or municipalities, but shall be paid only out of revenues received from the service charges as provided in the preceding section, or from a sale of the property and franchises under a foreclosure of the mortgage. If a service rate is charged, to be paid as herein provided, such portion thereof as may be deemed sufficient shall be set aside as a sinking fund for the payment of the interest on said bonds, and the principal thereof at maturity.

Section 5. Governmental agencies or municipalities as herein mentioned instead of owning and operating a sewer system and sewage disposal plant, garbage collection and disposal system, as herein provided, may grant a franchise for a period not to exceed thirty years to any private corporation organized under, or authorized by the laws of this State to engage in such business, to build, construct, own and operate a sewage or garbage disposal system for the purpose of receiving and treating sewage and night soil and garbage as hereinbefore mentioned from such governmental agencies or municipalities. Such franchise may authorize the corporation to charge each person, firm or corporation owning property from which such sewage or garbage is received such a fee therefor as may be determined to be reasonable by the Public Utilities Commission of this State, upon proper application made either by such corporation, governmental agencies or municipalities and after a hearing thereon. Such franchise may also grant to the corporation the right and privilege to lay all such necessary intercepting and other sewers and connecting pipes in the streets and public alleys of the governmental agencies or of the municipalties as may be necessary to receive and conduct the sewage to the disposal plant and under such reasonable rules, regulations and supervision as may be established by the governmental agencies or the municipalities. Any such franchise shall be void unless approved by three-fifths of the electors of such governmental agencies or municipalities voting thereon at any general or special election.

Section 6. Any such governmental agencies or municipalities may enter into a contract with any corporation organized under or authorized by the laws of this State to engage in the business herein mentioned, to receive and treat in the manner hereinbefore mentioned the sewage, night soil and garbage thereof. Such contract may authorize the corporation to charge the owners of the premises served such service rate therefor as the Public Utilities Commission of this State may determine to be just and reasonable, or the governmental agencies or municipalities may contract to pay the said corporation a flat rate for such service, and pay therefor out of their general fund or assess the owners of the property served a reasonable charge therefor to be collected as hereinbefore provided and paid into a fund to be used to defray such contract charges.

Section 7. Whenever a court of competent jurisdiction in this State shall have ordered the installation of a sewage or garbage disposal system in any of the governmental agencies or municipalities herein mentioned, and the plans therefor shall have been prepared, and approved by the State Commissioner of Health, the legislative body or the respective legislative bodies thereof shall have authority to issue and sell the necessary bonds for the construction and installation thereof, including the disposal plant, and such intercepting and other sewers as may be necessary to permit the effective operation of such system; such bonds to draw interest at not to exceed six per cent per annum, and payable in not to exceed thirty years from the date of issuance; the legislative body or the respective legislative bodies to determine the denomination of said bonds and the date, time and manner of payment. The amount of such bonds either issued or outstanding shall not be included in the amount of bonds which the said governmental agencies or municipalities may be authorized to issue under any statutes of this State or charters. Governmental agencies or municipalities issuing bonds hereunder in excess of the limit of the authorized bonded indebtedness fixed by statutes or charters, the principal and interest of which are not to be paid out of funds created from service charge, as hereinbefore provided, may raise such a sum annually by taxation as the legislative body or respective legislative bodies may deem necessary to pay interest on such bonds, and to create a sinking fund to pay the principal thereof as it falls due. Such annual amount may be in excess of the authorized annual tax rate fixed by the statutes or charters. Except as otherwise provided in this act, all bonds issued hereunder shall be issued and sold in conformity to the provisions of act number two hundred seventy-three of the Public Acts of nineteen hundred twenty-five or as it may hereafter be amended.

Section 8. Whenever an order shall have been made by any court of competent jurisdiction, as hereinbefore provided, the fact that such order was issued shall be recited in the official minutes of the legislative body or the respective legislative bodies. The said body or bodies shall thereupon require that plans and specifications be prepared of such sewage or garbage disposal system, including the necessary storm and sanitary sewers, which plans when submitted and approved by the legislative body or respective legislative bodies shall be submitted thereafter to the State Commissioner of Health for his approval. If such plans are so approved, the legislative body or respective legislative bodies shall thereupon authorize the issuance and sale of the necessary bonds to establish the proposed system.

Section 9. The authority hereby given shall be in addition to and not in derogation of any power existing in any of the counties, cities or villages under any statutory or charter provisions which they may now have or may hereafter adopt.

Section 10. Proceedings under this act shall be taken only in a court of competent jurisdiction in the county in which the proposed interceptors sewage or garbage disposal plants are to be constructed.

Section 12. Whenever it is deemed expedient for the safety and health of the people, governmental agencies and municipalities are hereby authorized to enter into agreement with each other to raise money, issue bonds to erect and maintain intercepting sewers and sewage treatment plants.

Section 13. Whenever governmental agencies and municipalities shall desire to act under the provisions of this law, the relationship established between such governmental agencies and municipalities shall be fixed by contract, and such contracts may be made by governmental agencies and municipalities under the provisions of this act in a manner and to the extent that natural persons might make contracts for like purposes. Such contracts before becoming operative shall be approved by a vote of the majority of the members elect of each of the respective legislative bodies of the governmental agencies and municipalities operating under the provisions of this act.

Secton 14. If any clause, sentence, paragraph, section or part of this act shall for any reason be adjudged or decreed to be invalid by any court of competent jurisdiction, such judgment or decree shall not affect, impair or invalidate the remainder of this act, but shall be confined in its operation to the clause, sentence, paragraph, section or part hereof directly involved in the controversy in which said judgment or decree shall have been rendered.

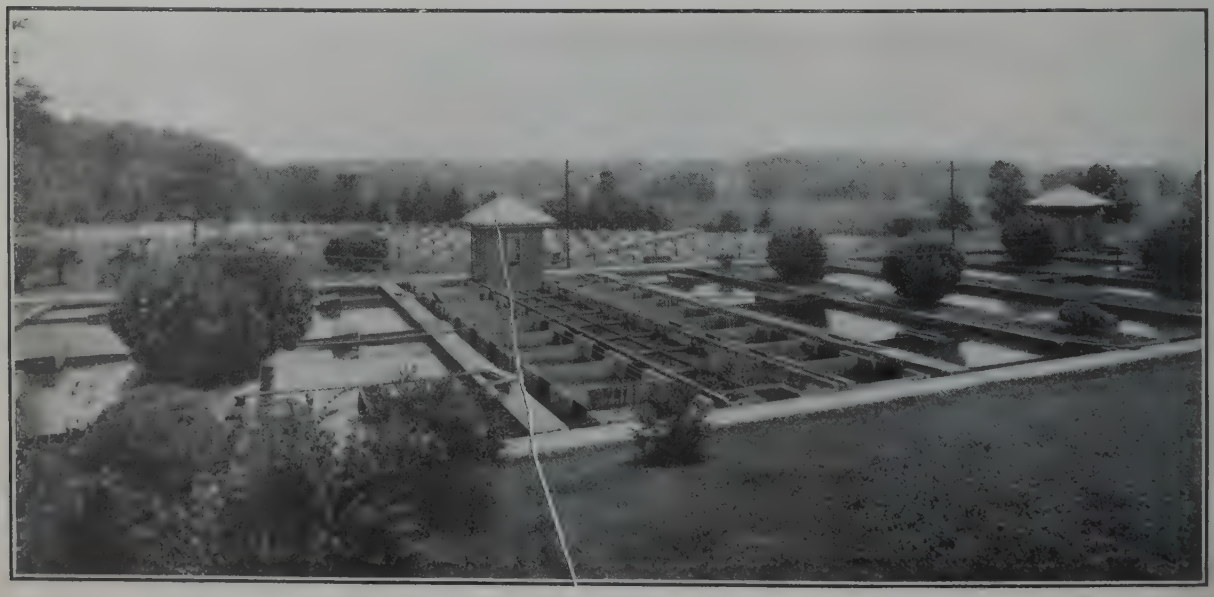
This act is ordered to take immediate effect.

OHIO SEWER RENTAL LAW

(Section numbers, Ohio General Code. Effective July 30, 1923.)

Sec. 3891—1. The council of any city or village which has installed or is installing sewerage, a system of sewerage, sewage pumping works or sewage treatment or disposal works for public use, may by ordinance establish just and equitable rates or charges of rents to be paid to such city or village for the use of such sewerage, a system of sewerage, sewage pumping works or sewage treatment or disposal works by every person, firm or corporation whose premises are served by a connection to such sewerage, system of sewerage, sewage pumping works or sewage treatment or disposal works. Such charges shall constitute a lien upon the property served by such connection and if not paid when due shall be collected in the same manner as other city and village taxes. The council may change such rates or charges from time to time as may be deemed advisable. Provided, however, that in a municipality operating under a municipal charter the council or other legislative body may establish the schedule of rates herein authorized and provide for its administration by designating the department or officer of the municipality to be charged with the enforcement of the provisions of this act. (110 v. 370.)

Sec. 3891—2. In a city the director of public service shall manage, conduct and control the sewerage system and sewage pumping, treatment and disposal works and when the council has established a schedule of rates or charges of rents for their use shall collect sewer rentals, and he shall appoint the necessary officers and agents for such purposes. (110 v. 370.)



Sewage Disposal Plant, Peach Creek, Atlanta, Ga.

Sec. 3891—3. When the council of a village has established a schedule of rates or charges of rents for the use of the sewerage system and sewage pumping, treatment and disposal works, the board of trustees of public affairs shall manage, conduct and control such sewerage system and sewage pumping, treatment and disposal works and shall collect sewer rentals and shall appoint necessary officers and agents for such purposes; and shall assume all duties, in relation to sewers, imposed upon the street commissioner by Section 4364 of the General Code, whereupon the street commissioner shall be relieved of such duties. (110 v. 370.)

Sec. 3891—4. The director of public service and the board of trustees of public affairs may make such by-laws and regulations as may be deemed necessary for the safe, economical and efficient management and protection of the sewerage system and sewage pumping treatment and disposal works; and for the construction and use of house sewers and connections to the sewerage system. Such by-laws and regulations shall have the same force and effect as ordinances when not repugnant thereto or to the constitution or laws of the state. (110 v. 370.)

Sec. 3891—5. The funds received from the collection of sewer rentals shall be deposited weekly with the treasurer of the corporation. Money so deposited shall be kept as a separate and distinct fund and shall be known as the sewer fund. When appropriated by council, it shall be subject to the order of the director of public service of a city or board of trustees of public affairs of a village. Such director or board shall sign all orders drawn on the treasurer of the corporation against such fund. This fund shall be used for the payment of the cost of the management, maintenance, operation and repair of the sewerage system and sewage pumping, treatment and disposal works and any surplus in such fund may be used for the enlargement or replacement of the same and for the payment of the interest on any debt incurred for the construction of such sewerage system and sewage pumping, treatment and disposal works, and for the creation of a sinking fund for the payment of such debt, but shall not be used for the extension of a sewerage system to serve unsewered areas or for any other purpose whatsoever. (110 v. 370.)

Acknowledgment.—The foregoing is a paper presented Oct. 23 at the 5th annual Missouri Water and Sewerage Conference.

Water Filtration Plants in Pennsylvania

Some interesting information on the purification of water in the state of Pennsylvania was given by H. E. Moses, Assistant Chief Engineer, Pennsylvania Department of Health, in a paper presented at the 33rd annual meeting of the Pennsylvania Water Works Association. The notes following are taken from his paper.

The first public water works in the United States were those of Boston, and built in 1652. Eighty-four years later the first Pennsylvania water works was installed at Schaeffertown in 1736. In this state, at Bethlehem, in 1754, there was put into operation the first water works pumping plant in the United States. One hundred and fifty-three years after the installation of the Schaeffertown works, Pennsylvania saw its first filter plant.

Records of the early water filtration plants are meagre, but it appears that in 1889 one was built at New Bethlehem, Clarion County. This was a single unit of the rapid sand type with a daily capacity of 150,000 gal. Three years later the next plant was built at Beaver Falls, Beaver County, replaced by a new plant in 1924, while the Gettysburg plant was installed in 1893.

Table I—Summary of Filtration Plants in Pennsylvania as of June 1, 1928

Type plant	No. plants	No. units	Million gals. daily Rated capacity	Water filtered	Population in district	No. of Consumers
Rapid	164	685	487.50	270.67	2,139,731	1,856,910
Slow	10	38	41.60	34.30	223,829	220,365
Slow and rapid	5	106	119.50	90.80	627,898	585,000
Preliminary and slow	4	91	258.50	238.50	1,543,500	1,393,400
Pretreated and slow	1	56	200.00	121.00	690,000	640,000
Coke and rapid	1	1	0.20	0.20	62,327	1,800
Pressure	9	27	12.13	6.44	88,950	69,950
Total	194	1,004	1,119.43	761.91	5,376,135	4,767,425

The growth by years is shown in the following table:

Record of Filtration Plants Installed According to Year First Built to June 1, 1928

Year	Plants No.	Year	Plants No.	Year	Plants No.
1889	2	1903	5	1917	8
1890	..	1904	6	1918	4
1891	..	1905	7	1919	4
1892	1	1906	8	1920	7
1893	..	1907	2	1921	9
1894	1	1908	8	1922	2
1895	3	1909	5	1923	8
1896	3	1910	11	1924	6
1897	2	1911	7	1925	9
1898	2	1912	7	1926	5
1899	..	1913	7	1927	7
1900	2	1914	16	1928	6
1901	2	1915	6		
1902	6	1916	5	Total	194

The growth by periods is well shown in the table below. It will be noted that the greatest number of plants were built from 1910 to 1919, but in terms of rated capacity the previous decade totaled three times the amount with only slightly more than one-half as many plants. However, this period includes the Pittsburgh and all of the Philadelphia plants, except Queen Lane. It means that 1910-1919 witnessed the extension of filtered water to many of the smaller communities outside the largest centers of population. This, likewise, was true, although to a lesser degree, from 1920 to 1928.

Installation of Plants by Periods

Type of plant	Period—Years exclusive 1889 1899	1900 1909	1910 1919	1920 1928 (June 1st)
Rapid	11	33	60	58
Slow	1	4	8	....
Slow and rapid	....	2	....	....
Preliminary and slow	....	4	1	....
Pretreated and slow	....	1	....	....
Coke and rapid	....	....	1	....
Pressure	2	2	5	1
Total plants	14	46	75	59
Rated capacity million gallons daily	38.35	559.11	199.32	104.21

NOTE: In above table plants are listed according to first year in which plant is built—new plants only.

As a contrast to the slow growth at the beginning, only 14 plants in the first 10 years, 16 plants were built in the last two years having an aggregate rated capacity of 60 m.g.d.

A summary of filtration plants as of June 1, 1928, is shown in Table I.

On June 1, 1928, there were in Pennsylvania 194 filtration plants, almost all of which are in daily operation, serving four and three-quarter million people and producing in round figures 760,000,000 gal. of water every 24 hours. These plants combined have a rated capacity of slightly more than 1,100 mil. gal. daily. In addition to being filtered the water is, with very few exceptions, also chlorinated.

Cost of Ice Water Drinking Fountains.—The Water Board of Cambridge, Mass., maintains nine ice water drinking fountains during the summer months. The average cost per day per fountain of furnishing the ice was $1.75 in 1928; $1.63 in 1927 and $1.75 in 1926.

Accounting for the Water Pumped at Dubuque, Ia.

The percentage of salable water and pumpage accounted for by the Water Works of Dubuque were as follows for the year ending March 31, 1929:

	Gal.	Per Cent
Salable	620,689,500	63½
No revenue	357,398,500	36½
Accounted for	713,516,500	73
Unaccounted for	264,572,500	27

The following table from the 29th report of the Water Department, of which John W. McEvoy is Superintendent, shows the uses of the water pumped during the year:

	Gal.
Salable water	620,689,500
General flush of distribution system	6,500,000
Flushing 1,218 hydrants at 7,500 gal. each	9,135,000
Extension and plumbers' ditches	2,000,000
Service leaks, 96 to 100,000 gal. each	9,600,000
Eight hydrants broken (30 min. at 1,000 gal. per min.)	240,000
Cleaning level reservoir (3 times)	1,500,000
Draining West Third St. Reservoir	4,000,000
Known leakage in West Third St. storage reservoir (24,000 gal. per day)	8,760,000
Meters tested at 35 gal. each	200,000
Eagle Point Station	2,000,000
By Pass from Low Pressure to Level Reservoir	2,592,000
Flushing city streets and sewers	20,000,000
Two horse fountains and 8 bubblers	8,800,000
Fire department	8,500,000
City parks (120 days at 10 hours)	3,000,000
Bathing beach and athletic field	1,500,000
Ice rinks (seven)	4,500,000
Free water furnished the city	46,300,000
Total accounted for	713,516,500

Pumpage accounted for divided by the actual pumpage equals the per cent of pumpage accounted for; 713,516,500 divided by 978,088,000 equals 73 per cent.

Control of Filter Washing

Studies Show That 2.7 Ft. Vertical Rise Most Economical

By EDWARD S. HOPKINS
Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.

DUE to the serious clogging of sand filter beds in different parts of the country there is an opinion among many plant operators that the accepted standard wash of 2 ft. vertical rise per minute is not sufficient to keep the beds in proper condition.

This study was undertaken for the purpose of learning, if possible, some relation between washing characteristics and maintenance of clean beds with subsequent long periods of operating service. It being assumed that clean beds would minimize the possibility of mud ball clogging.

Clarity as Criterion of Cleanliness.—When washing filters it is the usual practice to utilize the clarity of the final wash water as the criterion of the cleanliness of the bed. This clarity being determined solely by visual inspection of the operator as the water passes into the drain troughs. Testing 7 experienced filter operators it was found that the turbidity of such wash water varied from 25 to 150 p.p.m., depending upon individual psychology and light conditions. Since it is logical to expect the period of filter operating service (filter runs) to be more or less controlled by the cleanliness of the bed, therefore the cleaner the bed, the longer the "filter runs" with other conditions being equal, due to a minimum initial mud load. This assumption is confirmed by a study of the curves in Fig. 2. Using a constant filtration rate (125,000,000 gal. per acre per day) with the applied water properly coagulated, having a turbidity between 4 and 7 p.p.m., it is shown that a minimum final wash water turbidity gives a maximum period of operation.

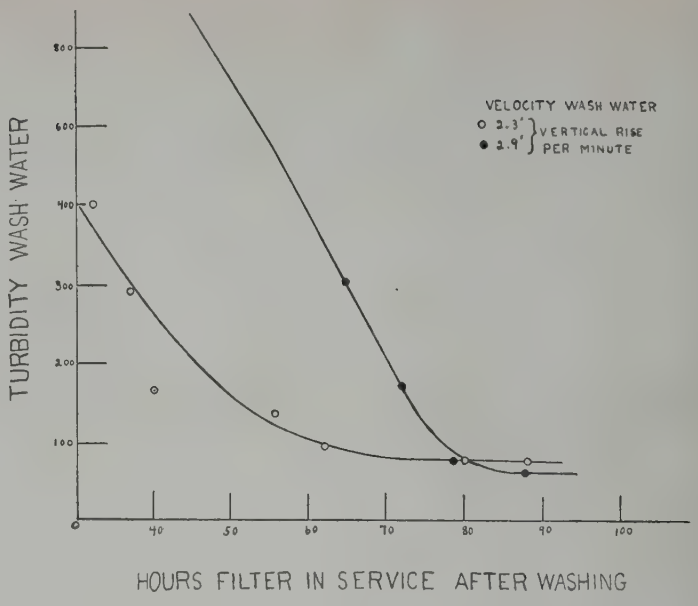


Fig. 2

Velocity a Factor.—These curves also indicate that the velocity of wash water is a factor in obtaining clean beds. When washing with a velocity of 2.9 ft. vertical rise per minute it will be noted that with a 1 minute wash and final wash water turbidity of 800 p.p.m. it was possible to obtain a filter run of 50 hours. Using a velocity of 2.3 ft. vertical rise, giving a turbidity of 400 p.p.m. for a similar period, a run of only 35 hours was obtained.

Further inspection of these curves show that the "filter runs" are practically constant for a final wash water turbidity of 75 p.p.m., thereby indicating that the bed is clean, with this condition existing for all velocities of wash water applied. Any increase in filter operating time greater than indicated, is due to the characteristics of the applied water rather than to washing conditions. These results confirm the belief that filters should be washed with the highest velocity comparable to plant design.

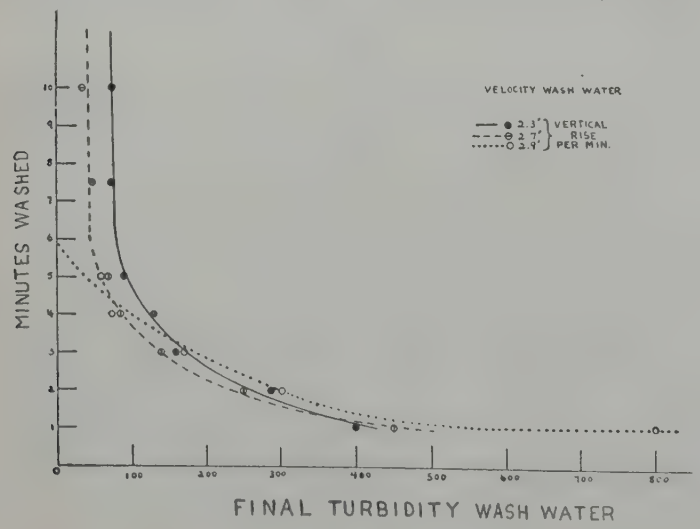


Fig. 1

Simple Control Method.—Since it is not practicable as routine procedure to make turbidity determinations of the wash water during the restricted washing period a simplier control method must be utilized. Such a control can be easily maintained by regulating the time of wash in relation to the velocity of wash water applied as shown in Fig. 1. Inspection of these curves will show that the maximum cleanliness of bed (75 p.p.m. final wash water turbidity) does not require prolonged washing. Filters washed in accordance with these curves would be in this ratio:

2.3 ft. vertical raise per minute, requires a 6-minute wash,
2.7 ft. vertical raise per minute, requires a 4-minute wash,
2.9 ft. vertical raise per minute, requires a 4-minute wash.

A 4-minute wash at 2.7 ft. vertical rise is, therefore, the most economical rate, thereby giving an easily controlled cleanliness of bed, with assurance that the maximum "filter runs" are being obtained. These results would indicate that the present accepted standard of 2 ft. vertical rise is inefficient and if plant design will permit the use of these higher velocities, without loss of sand, increased "filter runs" will be obtained.

Acknowledgment.—The above is a paper presented at the 1929 Conference of the Maryland Water and Sewerage Association.

Methods and Costs of Day Labor Construction of Water Mains and Sewers

Organization, Equipment and Methods Used by a Sanitary District in Maryland, and a Comparison of Cost of Machine and Hand Work in Trenching

By H. ROLAND DEVILBISS

Department Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

THE Washington Suburban Sanitary District lies partly in Prince George's and partly in Montgomery County, Maryland, adjacent to the District of Columbia, and has an area of about 94 square miles. In addition, Gaithersburg and Washington Grove, lying in the central section of Montgomery County and embracing an area of about one square mile, form a detached part of the Sanitary District.

Organization.—The office of the chief engineer, who has charge of all engineering activities, is divided into two main departments, construction and maintenance and operation, and four divisions, design and drafting, surveys, plumbing, and accounts. Each is under a department or division engineer, responsible to the chief and deputy chief engineers.

The construction department engineer has direct charge of the construction of all water and sewer lines, filtration plants, water and sewage pumping stations, sewage disposal plants, water and sewer connections, purchase of construction equipment, small tools and supplies, and the inspection and handling of all construction material. Working directly under the department engineer are two resident engineers, one in charge of the eastern district and the other the western district, who supervise the work of the day labor forces on main lines and house services, and also of contract work. Assisting each of these men is a line and grade party, consisting of an instrumentman and rodman, which sets lines and grades and takes final measurements of completed work. On contract work inspectors are furnished these districts, whose duties are to see that the work is carried along in strict accordance with the specifications. An assistant engineer in the office has charge of house connection records, sketches, and the issuance of permits; and in addition looks after the office work of the plumbing division. At the warehouse is a storekeeper and an assistant whose duties are to inspect and check the receipt of all materials and their delivery to the various projects to be constructed. Working under these men are mechanics, machine operators, blacksmiths, carpenters, truck drivers and a street repair gang. Machine operators on assignment to a district work directly under the resident engineer. A final inspector and his gang report to and work directly from the department engineer's office.

The size of the day labor forces varies in accordance with the volume of work to be completed during the year. The maximum number of day labor gangs on water and sewer lines has been 11 and the minimum 2, while the maximum number of laborers employed on this class of work has been 396 and the minimum 21. On water and sewer house connections the maximum number of gangs has been 5 and the minimum 1, while the maximum number of laborers has been 79 and the minimum 13.

Work Accomplished.—During the past ten years this organization has constructed or supervised the construction of 190 miles of water lines, ranging in size from 1¼ in. to 24-in., 113 miles of sewer lines, ranging in size from 6-in. to 30-in., two water filtration plants and pumping stations, one having a capacity of 3,500,000 gal. per day, the other a capacity of 1,000,000 gal. per day, several large standpipes and elevated tanks, a sewage disposal plant having a capacity of 250,000 gal. per day, and four small sewage pumping stations, two each with a pumping capacity of 70 gal. per minute, another with a pumping capacity of 350 gal. per minute, and another with a pumping capacity of 300 gal. per minute, at an approximate total cost of $5,000,000. In addition 9,114 water services, ranging in size from ¾ in. to 8 in., and 6,368 sewer services were built.

The above figures do not include existing water lines, sewers, and water and sewer connections, purchased and incorporated into the district's systems at the beginning of operations, which amounted to approximately 53 miles of water mains, 56 miles of sewers, 1,586 water services, and 1,650 sewer house connections; nor do they include the expenses incurred in the purchase of these systems, or in the replacement of many old lines, the lowering of main services, and other incidental capital costs.

Equipment.—The hauling equipment consists of five 3½-ton trucks, three 1-ton trucks, three 1-ton dump trucks, and one 1-ton truck with dump body. In addition, four 1-ton trucks are equipped for use by the water and sewer house connection gangs.

Our excavating equipment consists of four trenching machines, two having a digging depth of 12 ft. and a maximum width of 33 in., one having a digging depth of 10 ft. and a maximum width of 30 in. and the other a digging depth of 7 ft. at 24-in. width and a digging depth of 5 ft. at 42-in. width.

Where one class of pipe line work is to be constructed and depths do not vary widely, the purchase of excavating equipment becomes a simple problem. In this district the problem is quite different. The territory is extensive and in most cases the lines authorized for construction by the commission involve both water mains and sewers in a single project. The average length of these installations is probably not greater than 800 ft.

For backfilling purposes we have four machines on full caterpillars, and equipped with boom attachments. In addition to refilling, these machines are used in lifting large boulders and rocks from trenches, unloading pipe from cars, lowering pipe into trenches, and withdrawing shoring from trenches.

We have three compressors, one having a capacity of 165 cu. ft. per minute, another a capacity of 90 cu. ft. per minute, both mounted on steel wheels, and another having a capacity of 90 cu. ft. per minute, mounted on a truck. The two mounted on steel wheels are moved from job to job on our trucks and are used where heavy rock cuts are encountered, while the one mounted on the truck is generally used in breaking concrete and macadam, and on trench work where a light rock cut is found. With the latter machine, speed of transportation is the big item and this compressor has proven valuable in breaking concrete and macadam for service connections. We are well equipped with concrete breakers, jackhammers, tampers and spades.

We have one 1½-ton crane mounted on a 7-ton truck and equipped with a ½ cu. yd. clamshell bucket. This machine is used in unloading cast-iron pipe and fittings from freight cars, loading trucks in our store-yard, unloading and handling crushed stone, gravel, cinders, coal, and in lowering large cast-iron pipe into trenches.

The crane was used successfully in excavating approximately 2,000 ft. of trench, averaging 8 ft. in depth, for a 30-in. reinforced concrete sewer. This work was in close proximity to a stream

and in marshy land. The machine was moved in while the ground was frozen, placed on a plank platform on the center line of trench, and carried on this platform throughout the work, which terminated at a paved roadway.

The tractor equipment consists of four small tractors. These are used mostly in moving construction materials and equipment to jobs which are not accessible to truck deliveries. Practically all of our trunk sewer work and some of the cross-country water lines fall into this class. In emergencies the maintenance and operating department has used the tractors in driving low-lift centrifugal and deep well pumps.

For trench pumps we have, mounted on steel wheels, eight 2-hp. gasoline-driven diaphragm pumps with 4-in. suctions, having a rated capacity of from 8,000 to 10,000 gal. per hour. We have also a number of 3-in. diaphragm hand pumps.

Type of Pipe for Water Mains.—The distribution system has been constructed of a number of different types of cast-iron pipe, among which are sand-cast, deLavaud centrifugal, sand spun centrifugal, and McWane horizontally cast, without precaulked joints. The sand-cast pipe, in sizes up to 24 in., and the deLavaud centrifugal, in sizes up to 20 in., have been in 12-ft. lengths, with the exception that during 1920 a small percentage of the sand-cast was in 5-meter lengths. The sand spun centrifugal pipe, in sizes up to 12 in., has been in 16-ft. and the McWane pipe, which we have used only in the 6-in. size, has been in 16.5-ft. lengths. Nearly all of this material is purchased under competitive bidding.

No provision is made in our contracts for a differential on 16-ft. or 16.5-ft. lengths over 12-ft. lengths. During the past year, at the direction of the chief engineer, I prepared an estimate of the average saving per linear foot in laying 16.5-ft. lengths instead of 12-ft. lengths, on sizes ranging from 6-in. to 12-in., and the results are shown in Table I.

We have recently tried some 12-in. deLavaud pipe in 18-ft. lengths. It is too early to form a definite opinion of its advantages over 12-ft. lengths, but it is not suitable for curved pipe lines and there is difficulty in handling where trenches have to be braced.

Joints.—For jointing cast-iron mains, braided hemp packing and leadite are used. On lines crossing bridges a sleeve is placed near the center of the crossing and this joint, as well as joints on lines passing under streams, is poured with lead. In the former case the lead joints make additional provision for expansion and contraction in the line, and in the latter it has been found that lead in these locations is easier to repair, if necessary, than leadite. Some of the bridges on which we have water mains are subject to considerable vibration from heavy traffic. The leadite joints on bridges, however, have shown little leakage.

Fire Hydrants Have Sliding Frost Casing.—The type of fire hydrant used was designed by Mr. Robert B. Morse, Chief Engineer of the district. It has an attractive appearance and the internal parts are adapted from the standard Mathews hydrant manufactured by R. D. Wood & Co. One of the unusual features embodied in the design of the hydrant is a sliding frost casing, which for our purposes has a maximum range of 2 ft., although if desired the casing could be manufactured to give either a greater or smaller range of adjustment. In this district, where water lines are constructed in a majority of instances in advance of permanent grading, the adjustable frost case has proven to be of untold value. Hydrants manufactured for the district with the sliding frost casing are for 4½, 5, 5½ and 6½-ft. depths of trench. If the ground surface at the time of placing the hydrant required a 4½-ft. hydrant, the casing would be in a fully collapsed position with its top just above the ground, while if at a later date a fill was made and a 6½-ft. hydrant was required the barrel of the 4½-ft. hydrant would be removed, a 6½-ft. barrel inserted, and the frost casing extended to its full extent so as to allow its top to protrude slightly above the finished grade. The operation would be reversed if a 6½-ft. hydrant was originally required and the street was graded off sufficiently to make a 4½-ft. hydrant suitable. Intermediate lengths of hydrant, of course, are used as required by conditions. Only a slight amount of digging is necessary in adjusting sliding frost casings to new grades, materially reducing the expense involved in changing other types of hydrants.

In placing fire hydrants a pocket 18 in. deep and 24 in. wide is excavated directly beneath the location of the hydrant, and this space is filled with stone, gravel or brick bats. This bedding affords a solid foundation for the hydrant and also allows proper drainage. After the hydrant has been placed and well braced back of the elbow, it is surrounded with the same class of previous material to a point well above the drip.

All hydrants have a main valve opening of 5¼ in. Hydrant leads are 6 in. in diameter and leads off from mains larger than 6 in. have a valve placed on them three feet from the face of the hydrant.

Laying Water Mains.—Water mains are laid with nearly the same precision, as to grade, as are our sewer lines. The construction department is furnished with a profile of the street, together with the elevations of the invert of the line at the various stations. Grade lines are set on the surface by the line and grade party and the foreman is furnished with a cut sheet which is followed in the laying of the main. Each pipe is graded with a rod in the same manner as sewers are graded, while the alignment of the main is generally done by eye, but with great care, nevertheless.

During the first few years the depth at which mains were to be laid was determined by the engineer in the field. Most of the streets and roadways in which mains were built were not at finished grade, and sufficient information was not available in the field to form a basis for reliable judgment as to the probable future condition. The result was that in some cases we have had to return and lower the mains, while in others we have mains deeper than necessary, due to heavy fills subsequently made. At a later date, the construction plans showed a reasonable finished street grade, as well as existing ground surface and the desired invert line for the main. The cuts from the existing ground surface to invert were scaled from the drawings in the field and the foremen attempted to dig to the required depths. Although this method was better than the crude one originally adopted, and generally used elsewhere, it was far from satisfactory and was in turn superseded by the plan first described.

Lowering Mains.—During the past ten years we have lowered 2,200 ft. of 4-in., 2,500 ft. of 6-in., 6,500 ft. of 8-in., 56 ft. of 10-in., 50 ft. of 12-in. and 550 ft. of 16-in. water main, most of which lengths, however, were in the systems purchased.

No difficulty has been experienced in lowering mains with either lead or leadite joints. A great many lead joints after lowering require recaulking, while with care very little repair has been necessary with leadite joints. Once in a great while a leadite joint will leak slightly, in which case the material is cut out at this point and the void is caulked with lead wool.

Sewer Construction.—Our specifications for vitrified sewer pipe require that all pipe shall be what is commercially known as "first quality" pipe, shall be in 3-ft. lengths, deep and wide socket, and double strength on sizes from 15 in. up. They further require that the contractor furnishing the material must submit to the chief engineer the name or names of the firm or firms which are to supply the pipe, together with the manufacture or manufacturers and location of the factory. The right is also reserved to require

Table I

Size, In.	Leadite and Jute per ft., 12-ft. lengths	Leadite and Jute per ft., 16.5-ft. lengths	Saving on Materials, 16.5-ft. lengths	Estimated Saving on Labor, 16.5-ft. lengths	Total Saving in using 16.5-ft. lengths
6	$0.032	$0.028	$0.009	$0.005	$0.014
8	0.0451	0.0329	0.0122	0.008	0.0202
10	0.0563	0.0409	0.0154	0.009	0.0244
12	0.0717	0.0522	0.0195	0.010	0.0295

the contractor to furnish an affidavit from the manufacturer that all pipe furnished is No. 1 pipe and first class in every respect.

Laying Pipe.—One of the most important things in the construction of a sewer system is the proper alignment and grading of each line constructed. In our district each length of pipe as it is laid is tested for line with a plumb bob and with a grade pole for exact elevation. After completion of an extension the lines are gone over by an inspector whose duties are to clean the lines of any sand or mud deposits that may have gathered during construction, to see if the alignment and grades between manholes are correct, and to search for leakage and other defects that may be visible in the manholes and pipe lines.

Final inspection is made of both contract and day labor work and in very few cases has it been necessary to reopen a trench to correct for alignment and grade. Occasionally a crushed pipe is found and repaired.

Y-Branches.—At first we placed Y-branches on our lines for vacant lots as well as for the existing houses. Vacant lots, however, are often not developed as originally planned and we were not a great while in learning that efforts towards making intelligent provision for Y-branches to serve vacant lots were mostly wasted. Further, the expense of placing Y-branches was considerable and much of it was lost for all time.

We now place Y-branches to provide only for existing houses and cut in on the lines for additional connections, in the manner to be described later.

Joints.—The materials which we have used in jointing sewers are cement, Hydrolene-B, Jointite and G-K.

Cement was first used and probably successfully in dry trenches and at points where no fear from root penetration need be entertained. In wet trenches, however, where underdrains are not used and where difficulties are always encountered in keeping water down, it is practically impossible for a foreman to obtain consistently good cement joints. Again, for the engineer to be assured of a proper cement joint, as generally specified, backfill certainly should not be permitted until the cement has had the opportunity of taking a fairly good set. It is generally believed, or at least stated, that backfilling over cement joints may be carried on, with care, directly after pipe laying. Care in doing this consists of refilling over the center of the pipes between joints, the backfill finally reaching a point from which it gradually rolls down and covers the joint. Refilling then proceeds in the ordinary manner. All joints may not be disturbed by this method but if some of the recently made joints are opened up after being covered by several feet of backfill you will find in a great many cases that the cement which was applied outside of the annular space has been wasted. I firmly believe that cement can be used successfully only in dry trenches, where backfilling need not proceed until the cement has become hard, and at points where there is no danger from root penetration.

Tests for Joints in Wet Trenches.—Inasmuch as a large proportion of our sewers are laid in wet trenches, and owing to some differences of opinion as to the pouring of joints which were moist and in some cases partly submerged, a few tests were conducted to determine the character of joints that could be secured under these conditions. In making these tests 6-in. deep and wide socket pipe was used, having a well-defined scoring on the spigot and the inside of the bell. The joints were packed with untarred jute and a depth of 1½ in. was allowed for the bituminous material. Water in which the tests were conducted was about the same turbidity encountered in the average wet sewer trench.

First: A number of sections of two lengths each were placed horizontally, the joints were packed and the inside of the bell and the outside of the spigot were moistened by running a wet brush around them. The joint was poured without any difficulty whatever. After pouring the joint one end of the pipe was sealed and the joint was submerged under 2 ft. of water for a period of 18 hours. Infiltration was negligible, not amounting to more than a tablespoonful in this period. The bells were broken and left the material easily, and the joint was cut and pulled from the spigot just as easily. Slight adherence existed between the two surfaces but the material was well keyed into the scoring and this undoubtedly was preventing infiltration. The joint itself showed no imperfection.

Second: A number of joints were poured by different methods with the invert of the pipe submerged 2 in. These methods were:

A. The joints were packed and the pouring gate was made directly on top of the pipe. The material was then poured and allowed to run down on both sides of the pipe. In some cases we had a joint that showed a solid face, while in most of our attempts the material failed to run on the bottom of the joint. In those that showed a solid face we found that at the bottom only a thin crust existed on the face of the joint, the material failing to fill the bell at this point. There was no adherence between surfaces.

B. The pouring gate in this case was placed slightly to one side of the top of pipe and the poured material forced the water around ahead of it. This method showed some improvement and some very good joints were obtained. All joints showed perfect on the face, but we found, on examination, a few with imperfections which would have allowed considerable infiltration.

C. In this case a small opening was left between the runner and the face of the bell at the bottom of the joint. The gate was built on top of the pipe and the bituminous material running down on each side of the pipe forced the water out at the bottom. This opening was stopped quickly with a piece of clay as soon as the compound appeared and the pouring of the joint was then completed. A number of joints were poured in this way and in no case did we fail to get a good result. The adherence in this case was about the same as obtained with the surfaces moist.

Water and Sewer House Connections.—Water and sewer house connections are built by the district as far as the property line. Table II gives the charges for the several sizes of connections which have obtained since the work started. It will be noted that these charges are gradually increasing which can be largely ascribed to the fact that increased width of streets in new subdivisions and a greater number of paved streets have caused the cost of doing the work to become materially greater.

The costs include the tapping of the water main or sewer, the necessary piping and fitting to carry the service to the property line, and on water services the meter housing and the placing of the meter.

Water.—For water services we first used galvanized genuine wrought-iron pipe. This material was superseded several years later by 1¼-in. cast-iron pipe, and during the past two years we have used copper tubing for services ranging in size from ¾ in. to 1½ in. On services larger than these cast-iron pipe is still used.

While both water and sewer connections are desired to a property the water service is laid in the same trench with the sewer connection. This is accomplished by tamping the backfill over the sewer pipe to the point at which the service is to be placed and then wedging a few pieces of timber across the trench to support the tubing. If the applicant desires water service only and the main is on the opposite side of the street from the property to be served shafts are opened on both sides of the road and the connecting channel is made by means of a 2-in. earth auger made up in sections 2 ft. long. This method has been used successfully under roadways 20 ft. wide. The copper

Table II

	Water, Size						Sewer, Size	
Year	¾ in.	1 in.	1¼ in.	1½ in.	2 in.	Over 2 in.	6 in.	Over 6 in.
1919 to 1924	$25.00	$30.00	$35.00	$40.00	$50.00	At cost but	$25.00	At cost but
1924 to 1925	30.00	35.00	42.00	50.00	60.00	in no case	30.00	in no case
1925 to 1928	35.00	42.00	50.00	60.00	74.00	less than	35.00	less than
1928 to 1929	42.50	50.00	60.00	72.00	90.00	cost of 2 in.	42.50	cost of 6 in.

tubing is easily passed through the opening made by the auger.

Water mains are tapped at an angle of 45 deg. and the end of the copper tubing is bent into the shape of a goose neck and connected to the corporation cock by means of a copper to brass fitting. Where it is necessary to joint two pieces of tubing a copper to copper coupling is used. Meters are placed outside in a housing, either between the curb and sidewalk or just back of the sidewalk. At the meter housing the tubing is bent to an angle of 90 deg. and carried vertically up through the housing and connected to the inlet side of a meter yoke by means of a copper to iron fitting. From the outlet side of the meter yoke galvanized genuine wrought-iron pipe is used to the property line.

Water services are laid at a minimum depth of 4 ft. The meter housing for ⅝-in. and ¾-in. meters consists of 18-in. terra cotta pipe 2 ft. long on which is placed a hollow concrete truncated cone 18 in. by 15 in. by 18 in. high. The frame and cover rest on this cone, making the total depth of the housing 46 in.

The meter yoke is equipped with a cut-off valve on the inlet side, which eliminates the need of curb cocks and boxes. Yokes are so placed that the inlet and outlet of the meter are 18 in. below the surface.

Water services are divided into two classes, single and double. Single water connections are mostly ¾ in. in diameter and provide service for one house. A double connection provides service for two houses and is usually 1 in. in diameter to the under side of the meter yoke where it is divided by a 1-in. by ¾-in. by ¾-in. tee, the branches of which are connected to the inlets of the two meter yokes which are placed in one housing. From the outlet sides of the yokes ¾-in. pipes are extended to the individual property lines. This type of connection, as a rule, is located near the dividing line between the properties served.

Sewer Connections.—As previously stated Y-branches are placed only to serve existing houses. As vacant lots are developed provisions for tapping the sewers must be made. For this purpose on sewers from 8 in. to 15 in. in diameter we have been using what is commercially known as a Washington Standard Thimble-Y. The Thimble-Y is an extra heavy soil pipe fitting and is made in 5-in. and 6-in. sizes. To place the Thimble-Y it is necessary to cut an opening in the side of the sewer slightly larger than the diameter of the connection to be made. The Y has a thin spigot 1 in. in depth which is placed in above-mentioned opening and is prevented from protruding into the barrel of the sewer by a flange which fits neatly against the barrel of the pipe. A concrete collar is then placed around the Y and extends one foot on each side of the tap made in the sewer. Occasionally, a length of pipe is broken in cutting the opening but the percentage of breaks, as compared with the number of taps made, is small.

Following suggestions of the chief engineer our office has recently designed a much lighter and less costly, but just as serviceable, sewer thimble, which is now being manufactured and will be used hereafter.

On 6-in. sewers the line is broken and a regular terra cotta Y-branch is inserted.

All ordinary sewer house connections are 6 in. in diameter and, when possible, are so laid as to give a cover of at least 7 ft. at the property line, except where houses are on a terrace.

Sewer connections are divided into two classes, single and double, the single connection being constructed in the ordinary manner, while the double is laid as one connection to a point between the curb and property line, where it divides by means of a Y, one branch going straight to one property and the other branch going at an angle of 45 deg. to the adjoining property.

Costs.—Perhaps a discussion of recent costs will prove more interesting than will one of the costs of several years ago when wages and prices of materials were constantly changing. During the past two years these items have been fairly stable and therefore, in Tables III and IV are shown the volume of work done and costs for the years 1927 and 1928, respectively, on both water mains and sewer lines constructed by the district's day labor forces. In addition, these tables further show a comparison of costs of machine work versus hand work.

The costs shown in these tables include every expense incident upon the work—labor, materials, supplies, small tools, equipment, transportation, repaving, maintenance of trenches for a period of three months, engineering (including surveying and designing) and administration. On water mains the costs include foundry inspection, fittings, valves, valve boxes, fire hydrant leads and fire hydrants; and on sewer lines they include manholes, manhole steps and manhole frames and covers—in other words, the lines complete. The costs per lineal foot include, therefore, every item of expense incurred from the time the project is authorized for construction by the commission until it is completed and placed in operation.

In 1927, 90 water projects were constructed having an average length of approximately 591 ft., and 58 sewer projects having an average length of 382 ft.; while, in 1928, 119 water projects were constructed having an average length of approximately 755 ft., and 66 sewer projects having an average length of 837 ft. From this one can readily see the number of times our gangs are moved during the course

Table III—Comparison of Cost Machine Work Versus Hand Work—1927

Size	Method	Water: Feet Laid	Water: Total Cost	Water: Cost per Ft.	Sewer: Feet Laid	Sewer: Total Cost	Sewer: Cost per Ft.
2 in. and less	Machine	934	$ 1,084.06	$1.160	.....	.....	.....
	Hand	674	960.75	1.427	.....	.....	.....
3 in.	Machine	102	187.59	1.838	.....	.....	.....
	Hand	538	1,009.21	1.875	.....	.....	.....
4 in.	Machine	.....	.....	.....	.....	.....	.....
	Hand	.....	.....	.....	.....	.....	.....
6 in.	Machine	17,614	33,688.19	1.912	4,683	$ 7,887.52	$1.684
	Hand	4,357	13,200.78	3.029	3,061	7,840.20	2.561
8 in.	Machine	9,025	24,582.54	2.723	8,235	15,124.98	1.836
	Hand	2,430	8,495.46	3.495	1,670	5,891.50	3.587
10 in.	Machine	5,881	18,938.97	3.220	1,813	3,682.60	2.031
	Hand	936	4,197.59	4.484	697	3,828.80	5.493
12 in.	Machine	1,643	6,370.61	3.877	.....	.....	.....
	Hand	4,310	18,075.13	4.293	.....	.....	.....
16 in.	Machine	352	1,555.39	4.418	.....	.....	.....
	Hand	3,900	19,120.35	4.903	.....	.....	.....
20 in.	Machine	648	5,476.36	8.451	.....	.....	.....
	Hand	.....	.....	.....	.....	.....	.....
24 in.	Machine	.....	.....	.....	.....	.....	.....
	Hand	.....	.....	.....	2,011	20,721.32	10.304
Totals and averages	Machine	36,199	$91,883.71	$2.538	14,731	$26,695.10	$1.805
	Hand	17,044	65,059.27	3.818	7,439	38,281.82	5.146

Table IV—Comparison of Cost Machine Work Versus Hand Work—1928

Size	Method	Water: Feet Laid	Water: Total Cost	Water: Cost per Ft.	Sewer: Feet Laid	Sewer: Total Cost	Sewer: Cost per Ft.
2 in. and less	Machine	992	$ 1,413.02	$1.526	.....	.....	.....
	Hand	516	644.16	1.248	.....	.....	.....
3 in.	Machine	87	111.79	1.282	.....	.....	.....
	Hand	388	1,041.52	2.684	.....	.....	.....
4 in.	Machine	2,024	2,520.47	1.245	.....	.....	.....
	Hand	544	1,163.83	2.139	.....	.....	.....
6 in.	Machine	37,582	64,675.55	1.720	19,138	$31,700.61	$1.656
	Hand	1,010	3,288.64	3.256	907	2,583.88	2.848
8 in.	Machine	30,361	64,596.93	2.126	27,656	53,039.99	1.918
	Hand	1,075	2,376.73	2.289	681	1,570.13	2.305
10 in.	Machine	9,357	24,677.96	2.637	5,331	10,191.92	1.912
	Hand	123	422.44	3.434	.....	.....	.....
12 in.	Machine	3,605	14,219.71	3.944	324	1,064.01	3.284
	Hand	1,369	6,612.40	4.830	.....	.....	.....
15 in.	Machine	.....	.....	.....	.....	.....	.....
	Hand	.....	.....	.....	.....	.....	.....
16 in.	Machine	863	3,541.34	4.103	1,259	5,835.84	4.635
	Hand	.....	.....	.....	.....	.....	.....
Totals and averages	Machine	84,871	$175,756.77	$2.083	52,449	$95,996.53	$1.830
	Hand	5,025	15,549.71	3.094	2,847	9,989.85	3.509

of a year, and moving from one project to another involves considerable expense, not only in the actual cost of moving, but also in the loss of time. Where possible, the move is made after working hours and the latter loss eliminated, but in the majority of cases the move, unfortunately, has to be made during hours.

On water mains our standards require a minimum cover of 4 ft. In a great many sections of the district the streets have not been cut down to the final grade and the mains consequently have to be laid at an excessive depth, anticipating that some time in the future the street will be brought to a finished grade. While we do not classify our excavation depths on day labor work, the writer feels safe in saying that the average depth of water trenches on all sizes of water mains is at least 6 ft. Naturally, these ungraded streets increase the depths of the sewers and frequently to an amount greater than our machines will excavate, thereby making it necessary to handle this deeper excavation by hand.

In the northern and western sections of the district considerable rock is encountered, while in the southern and eastern sections we have to contend with caving ground, water, silt and quicksand.

Machine Work Versus Hand Work.—Some work on machine jobs necessarily has to be done by hand; for example, the crossing of gas mains and services, culverts, tunneling of improved roadways and operations in the proximity of trees, poles, etc. This kind of hand work is included in the tabulated machine costs, while in the hand work costs no machinery whatever was employed.

In Table IV it will be noted that machine work on 2-in. mains and smaller costs $0.28 more per foot than did hand work. Only parts of these jobs could be done by machine on account of rock. This, together with the small volume of work done, caused the cost to be exceedingly high. Again, in Table III, it will be noted that the cost of a short line of 20-in. water main was $8.45 per foot. This job was located in the eastern section of the district, in an ungraded street, which required the main to be laid at an average depth of 8 ft. At a depth of 3 ft. quicksand and water were encountered, necessitating the balance of the excavation to be done by hand, tight shoring driven, and pumps operated 24 hours per day. In addition to these troubles, a rainy period of several days occurred during the course of construction. These cases are mentioned merely to show conditions frequently met with in the district. Similar cases could be cited on other sizes of lines.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1929 Conference of the Maryland Water and Sewerage Association.

A New Lining for Cast Iron Pipe

The engineers of the Wailes Dove-Hermiston Corporation, working in cooperation with the engineers of the United States Pipe & Foundry Company, have recently developed an efficient method for lining cast iron pipe with their bitumastic material. Although the bitumastic lining is not a new development in the field of pipe construction, except in cases of extreme necessity the difficulty of application of this lining to the inner surface of large diameter pipe has hitherto been a handicap to its widespread use. The old method of applying it with a brush was tedious, expensive and slow. The new method recently developed is efficient, rapid and economical.

The applications of this lining to the trade are numerous indeed. Bitumastic Lining is stated to be completely resistant to both concentrated and dilute acids, as well as to alkalis and corrosive liquids of all types and degrees. For piping systems which carry waters strongly impregnated with sulphur, and whose reaction is therefore slightly acid, the use of bitumastic lining is claimed to be ideal. When the water is alkaline, the corrosive effect on the bitumastic lining is stated to be nil.

In addition to the resistance of this lining to the various liquids which may be passed through the pipe, the smooth glossy surface is stated to present no lodging place for tubercles, barnacles or other growths with which it may come in contact. The smooth glossy surface, which resembles baker enamel, is claimed to permit the liquids to flow through the pipe with considerably less frictional loss than is the case with uncoated pipe, thus producing a greater pipe line efficiency.

The new method of applying this lining makes use of a new application of an old theory—that of centrifugal force. The bitumastic enamel is heated in a cauldron to the proper melting temperature. The pipe to be coated has previously been dipped in a priming coat and has been allowed to completely dry. The pipe is placed on rollers, driven by an electric motor, and is caused to rotate rapidly. The correct amount of bitumastic enamel, being now quite fluid, is poured into a steam-heated trough which is run into the rotating pipe and tipped over evenly, distributing the bitumastic lining along the entire length of the pipe. In a moment the material is distributed by centrifugal force over the entire inner surface of the pipe, and rotation is continued until the material has completely hardened. If a double lining is required, the second layer is put in before the first is entirely solidified. Thus, a layer of Bitumastic Enamel may be applied of any desired thickness without difficulty.

On Sept. 24th, a number of hydraulic engineers, who are especially interested in the elimination of corrosion or tuberculation on the inside of cast iron pipe lines, were invited to the Burlington Plant of the United States Pipe & Foundry Company to witness a demonstration of the application of the lining by this process. Fifty prominent engineers from New York, Philadelphia, Baltimore and points more remote responded. Two pipe were lined, both 48 in. in diameter, and both pipe were handled with ease and dispatch by the perfectly trained crew. The first pipe contained a standard lining approximately $\frac{5}{32}$ in. thick, while the second was lined with double thickness. Great admiration was expressed by all present over the efficient manner in which the work was done as well as over the excellence of the effect produced.

Due to the character of the water carried in certain sections of the country, tuberculation in pipe lines has, over a period of years, reduced the carrying capacity of these lines. Engineers are of the opinion that the use of the bitumastic lining will eliminate this trouble. An example of the efficiency of the bitumastic lining will be found in the parallel 36-in. and 42-in. lines which form the Narrows Siphons carrying the water supply to Staten Island, New York. The older of these lines has been in service over 15 years, carrying soft water. The last examination showed the bitumastic lining to be in excellent condition, and the lines have retained their full carrying capacity.

Silting of Reservoirs

In a discussion in Vol. 93, 1929 Transactions of the American Society of Civil Engineers, R. L. Meeker, Consulting Engineer, Denver, Colo., gives the following table summarizing the losses in various reservoirs in the southwest from silt deposition:

Silt Deposition, Channel Reservoirs, Southwestern United States

Reservoir	Stream	State	Drainage area in square miles	Original capacity, in acre-feet	Silt Deposition: Lost capacity, in acre-feet	Silt Deposition: Period, in years	Percentage of original capacity
Elephant Butte	Rio Grande	New Mexico	30,000	2,368,000	220,000	11-1915-1925	9
Roosevelt	Salt	Arizona	5,760	1,367,000	101,000	20-1906-1925	7
Austin	Colorado	Texas	38,000	*49,300	23,559	8-1893-1900	48
				32,029	30,552	13-1913-1926	95
McMillan	Pecos	New Mexico	.....	28,732	12,232	10-1895-1904	42
Zuni	Zuni	New Mexico	500	10,230	9,689	22-1905-1927	95
Castlewood	Cherry Creek	Colorado	165	5,267	†	38-1890-1927	†
Buckhorn	Buckhorn Creek	Colorado	130	1,191	565	18-1907-1925	47

*Old reservoir.
†Precise data are not available at this time.

New Water Supply for Los Angeles

Surveys Now Under Way for Supply from Mono Basin

SURVEYS are being made by engineers of the water department of Los Angeles, Calif., to determine the feasibility of securing an additional water supply from the Mono Basin to tide the city over until a supply from the Colorado River is available. The plan, in brief, according to the Los Angeles Times, from which these notes and the illustration are taken, provides for collecting the water in a reservoir on Rush Creek, its transportation through a tunnel into the Owens Valley water shed and thence into the Los Angeles aqueduct system, via the Owens River. An alternative plan routes the collected water around the south end of Mono Lake, through Adobe Valley and down into the Owens Valley near Bishop, via Fish Slough. It is expected the engineers' report on the project will be completed by the first of the year.

The Mono Basin is just north of Owens Valley, being separated from the valley by a formation of volcanic hills. The water available in the basin is estimated at from 180 to 235 second feet. The streams flowing into this basin from the High Sierras include Parker Creek, Walker Creek, Leevining Creek, Rush Creek and possibly Mill Creek. All plans call, first, for the collection of the flow of the above streams into a common channel. This channel, which will start from Leevining Creek, would consist of a series of open canals and tunnels intercepting the streams. It would deliver the water into a proposed reservoir on Rush Creek, formed by the erection of a 150-ft. concrete dam.

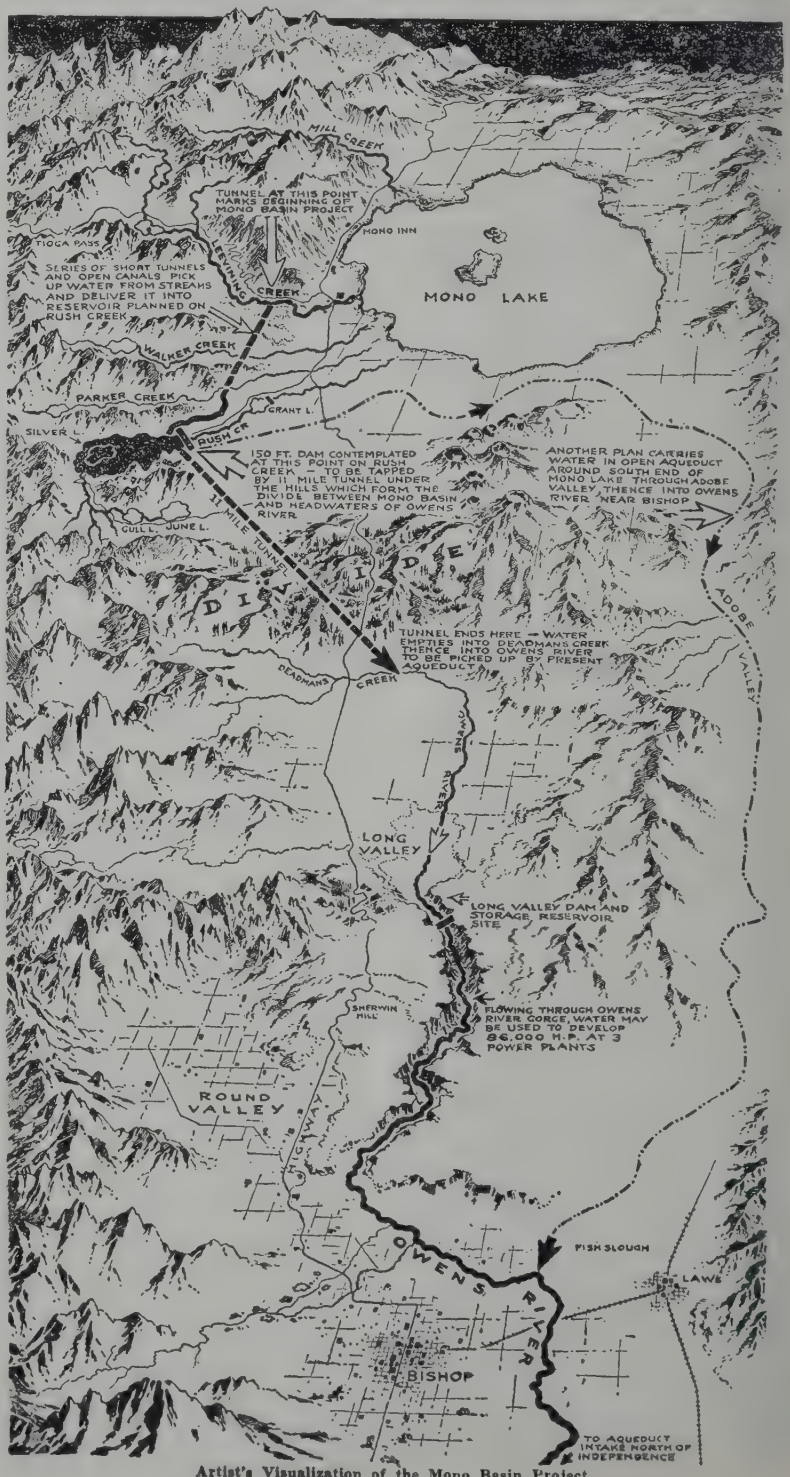
Later the collecting channel that picks up the water from the streams may be extended north beyond Leevining Creek to tap Mill Creek if economically feasible.

An 11-mile tunnel would tap the reservoir on Rush Creek and carry the water under the divide that separates Mono Basin from the Owens Valley, emptying it into Deadman's Creek, which forms the headwaters of the Owens River. The Owens River furnishes the bulk of the flow in the aqueduct, and so once the Mono water gets into the Owens River it is a part of the aqueduct system.

The Owens River flows through Long Valley and into the spectacular Owens River gorge, a very deep chasm 23 miles long. At the head of the gorge it is proposed to erect the Long Valley dam to provide storage capacity and also control the flow of the river through the gorge. The city has an easement on all the lands in the valley that would be covered by water with the building of a 100-ft. dam. Coming through the gorge there is a possible power development of about 86,000 hp. at three possible sites.

The cost of the development is estimated roughly at $30,000,000, this figure including the following:

Water rights: Southern Sierras Power Co., $8,000,000; private holdings, $2,000,000; $6,000,000 to get the water into the Owens River water shed, including cost of tunnels, dam and the like; and another $10,000,000 to buy up the remaining ranch lands and towns in the Owens Valley. In addition, there will be cost of enlarging the aqueduct to handle the combined Owens Valley and Mono basin waters.


MILL CREEK
TUNNEL AT THIS POINT MARKS BEGINNING OF MONO BASIN PROJECT
TIOGA PASS
MONO INN
SERIES OF SHORT TUNNELS AND OPEN CANALS PICK UP WATER FROM STREAMS AND DELIVER IT INTO RESERVOIR PLANNED ON RUSH CREEK
LEEVINING CREEK
MONO LAKE
WALKER CREEK
PARKER CREEK
GRANT L.
SILVER
RUSH CR.
150 FT. DAM CONTEMPLATED AT THIS POINT ON RUSH CREEK — TO BE TAPPED BY 11 MILE TUNNEL UNDER THE HILLS WHICH FORM THE DIVIDE BETWEEN MONO BASIN AND HEADWATERS OF OWENS RIVER
ANOTHER PLAN CARRIES WATER IN OPEN AQUEDUCT AROUND SOUTH END OF MONO LAKE THROUGH ADOBE VALLEY, THENCE INTO OWENS RIVER NEAR BISHOP
GULL L.
JUNE L.
11 MILE TUNNEL
DIVIDE
TUNNEL ENDS HERE — WATER EMPTIES INTO DEADMANS CREEK THENCE INTO OWENS RIVER TO BE PICKED UP BY PRESENT AQUEDUCT
ADOBE VALLEY
DEADMANS CREEK
LONG VALLEY
LONG VALLEY DAM AND STORAGE RESERVOIR SITE
SHERWIN MILL
FLOWING THROUGH OWENS RIVER GORGE, WATER MAY BE USED TO DEVELOP 86,000 H.P. AT 3 POWER PLANTS
ROUND VALLEY
OWENS RIVER
FISH SLOUGH
LAWE
BISHOP
TO AQUEDUCT INTAKE NORTH OF INDEPENDENCE

Artist's Visualization of the Mono Basin Project

Sewage Discharge from Submerged Outlets

Salinity of Body of Water Receiving Sewage an Important Factor in Its Diffusion, Oxidation and Decomposition

By KENNETH ALLEN

Sanitary Engineer, Office of Chief Engineer, Board of Estimate and Apportionment, New York, N. Y.

THE phenomenon of the course and diffusion of sewage discharged from submerged outlets is one that has rarely received close study, although the general results have been long recognized.

In inland cities the phenomena accompanying the discharge of sewage from submerged outlets in lakes and rivers will differ radically from those to be observed in salt water.

The effect of salinity was brought out very clearly in experiments made by the writer for the Metropolitan Sewerage Commission of New York in 1909. Owing to the configuration of the harbor, the flow of upland water brought down by the Hudson River, and the action of the tides, the percentage of sea water was found to average 74.8 at West Bank Light in the Lower Bay and 33.7 in the Hudson River off Fort Washington Point. The extreme readings noted at those points during the year were 93.2 per cent at West Bank Light on Nov. 5, and 0 per cent at Fort Washington Point on April 8. Conditions varied, therefore, from those of fresh water to those of nearly pure sea water.

Several series of experiments were made to learn more of the action of sewage discharged into waters of different specific gravities.

Experiments on Flotation.—Croquet balls were weighed until they balanced in water of a specific gravity of 1.000, and then released in water of known specific gravity at a given depth.* The time required for the balls to rise to the surface was noted with a stopwatch. (See Table I.)

The results, while not entirely consistent, give a fair idea of upward velocities of smooth solids released in waters of different density that will not be reached by a diffusing liquid. Bottles, released in a similar way, rose even more rapidly, on account of their smoother surfaces.

Laboratory Experiments in Diffusion.—A total of 31 experiments was made to observe the action of a dyed sewage or water when discharged from a pipette, or small tube, in waters of different salinity. Alcoholic solutions of eosin and fluorescein and aqueous solutions of bluing, permanganate of potash, and uranine were tried. The dye, especially the bluing, was found to increase the specific gravity slightly, and it was feared that alcohol might affect diffusion. Permanganate of potash was likely to be decolorized by organic matter. It was finally decided to use uranine ($C_{20}H_{10}O_5Na_2$) which, in a strong solution, is a deep red, but becomes a brilliant green on dilution, readily detected in a Nessler tube in a 1:20,000,000 dilution. A dye called "Special Scarlet" was used later and was found to be a very serviceable and less expensive substitute.

These experiments indicated clearly the effect of specific gravity and the way in which a drop or a jet diffused. Some of the forms observed were beautiful as well as interesting: Waves of floc; rings like smoke rings; funnels; and cones and wavy threadlike lines, rising or falling, and diffusing rapidly or slowly. The diffusion of 2 cu.cm. of a 1 per cent solution of uranine added gently to the surface of 200 cu. cm. of waters of varying salinity in beakers and jars began in a few minutes, was complete in an hour with tap water, and took 48 hours in a mixture containing 25 per cent of sea water, while it had not occurred with a 75 per cent mixture of sea water in a week's time. (See Table II.) Salinity, therefore, was shown to have a marked effect on diffusion.

Experiments in Diffusion in the New York City Aquarium.—These experiments, twelve in number, were made to confirm the results obtained in the laboratory before conducting others on a large scale in the open water. The tank was 4 ft. high, 4 ft. wide at the top, narrowing to about 3 ft. at the bottom, and 8 ft. long, with an overflow a few inches below the top. The dye and water were fed from a funnel and by a tube to a nozzle, the depth and direction of which were adjustable. Nozzles of ¼ in., ⅜ in., and ½ in. were used.

Without going into the details of these experiments, some of the results were as follows:

(a) With a horizontal jet a considerable current may be induced at a slight depth without apparent effect on the surface itself.

(b) With a ¼-in. horizontal jet of fresh water in fresh water, under a head of 1.0 ft., the axis of the jet remained horizontal, enlarging in diameter to 3 in. at a distance of 1.25 ft. from the nozzle and to 6 in. at a distance of 3.0 ft. from the nozzle, and then diffusing slowly. After substituting a jet of sewage, the diameter 3.0 ft. from the nozzle was 12 in.

(c) In the case of a ¼-in. upward jet of fresh water at a depth of 3.0 ft. in fresh water under a head of 2.5 ft., the jet formed a concave cone 5 in. in diameter 1.0 ft. from the nozzle and spread in a thin layer at the surface. By the end of 5 min. diffusion was quite uniform to a depth of 1.5 ft.

(d) With a ½-in. horizontal jet of sewage in fresh water near the bottom of the tank, 3.4 ft. below the surface and under a head of 0.15 ft., there was a gradual descent of the jet to the tank bottom which it covered with a blanket about 2 in. thick, with very little diffusion, in 3 min. The temperature of the sewage was 62° Fahr., with a specific gravity of 1.001. The temperature of the water was 61° Fahr., and its specific gravity was 1.000.

(e) With a ½-in. jet (nearly horizontal) of sewage in harbor water, at a depth of 3.3 ft. and under a head of 0.15 ft., a temperature of sewage 62° Fahr., specific gravity, 1.0015, and a temperature of water, 58° Fahr., the effluent rose promptly in an upward curving cone, reaching the surface in 1 min., where it spread out. At the end of 3 min. the supply of dye was cut off and by the end of 5 min. there remained but a thin green layer at the surface.

(f) For a ¼-in. horizontal jet of sewage in harbor water, as in Result (e), under a head of 1.0 ft., the diameter in a plane 1.0 ft. above the nozzle was 8 in. The horizontal component of the jet did not appear to affect the time taken to reach the surface.

Table I—Experiments to Determine Upward Velocity of Smooth Solids

Experiment No.	Number of tests	Specific gravity of water	Vertical distance traveled, in feet	Average velocity, in feet per second
1	13	1.0215	1.47-1.51	0.500
2	10	1.016	1.70	0.455
3	15	1.007	1.62	0.252
4	15	1.009	1.62	0.301
5	4	1.0195	10.0	0.655
6	10	1.0215	10.0	0.49

*The salinity of sea water varies in different parts of the ocean, but for this region chlorine of 18,000 parts per million, corresponding to a specific gravity of 1.025, was assumed as constituting 100 per cent.

(g) With a ¼-in. upward jet of sewage in harbor water, at a depth of 2.5 ft., and under a head of 1.0 ft., the sewage rose promptly to the surface with little diffusion and then spread in a thin layer. The diameter 2 ft. above the nozzle was 6 in.

(h) At a ¼-in. downward jet of sewage in harbor water, under a head of 1.0 ft., the jet rose as a column of greater diameter and with more rapid diffusion than in Result (g) and spread at the surface. Diffusion was increased materially by a slight agitation of the water.

The results of these experiments are generally confirmed by the work of the authors and by a similar apparatus, but their analysis has been carried to a point where the path of a jet of fresh water in sea water may be more closely predicted.

Experiments on Diffusion in New York Harbor.—Nine experiments were made by placing a dye in the surface water of the harbor, or at sewer outlets, to observe the rate at which sewage might be expected to become diffused and dispersed under different conditions. These were followed by 21 experiments to observe the result of discharging dyed water at various depths and locations in the harbor.

In three experiments at the outlet proposed at that time for the Bronx Valley Sewer, in the Hudson River, off Mount St. Vincent, dyed water was pumped at rates of 17 to 25 gal. per min., to depths varying from 5 to 25 ft. through a 1¼-in. hose. The velocity of the river water varied from 0 to 3 ft. per sec., and its specific gravity varied from 1.010 to 1.013. The detection of dye at the surface was uncertain at slack water from depths greater than 16 ft., or in a current of 2½ ft. per sec. from depths greater than 9 ft.

Nine similar experiments were made at various points in New York Bay, Gravesend Bay, and the Upper East River. These indicated that:

(a) With a difference in specific gravity of 0.004, dyed water will rise in quiet harbor water from depths of 10 to 26 ft. at a mean rate of 0.10 to 0.14 ft. per sec., and be visible at the surface.

(b) With a difference in specific gravity of 0.004½, it will rise from a depth of 18 ft. at a mean rate of 0.17 ft. per sec. and be visible at the surface.

(c) With a difference in specific gravity of 0.016, it will rise from a depth of 27 ft. in a current of 1½ ft. per sec. at a mean rate of about 0.10 ft. per sec., and be visible at the surface.

(d) In moderate currents dyed water may be expected to be visible at the surface if discharged at depths of 15 to 20 ft., but that the rate of ascent is variable. The limit from which it can be discovered under the most favorable conditions appears to be about 40 ft. In sea water (specific gravity, 1.021½), with a current of 0.3 ft. per sec., diffusion is very gradual at first, but proceeds more rapidly later.

Two similar experiments, but on a larger scale, were made in the Upper Bay, near the site of the Passaic Valley Sewer outlet off Robbins Reef, which has since been built.

In the first experiment, 16,500 gal. of a 1:2,750 solution of uranine in tap water was discharged 40 ft. below the surface through a 2½-in. hose, at a rate of 205 gal. per min., giving a velocity of 14 ft. per sec. The specific gravity of the harbor water varied from 1.0115 to 1.0135.

In the second experiment, 56,000 gal. of tap-water containing 290 lb. of uranine, forming a solution with a specific gravity of 1.003, was pumped from a pontoon through an 8-in. pipe, at a rate of about 2,320 gal. per min., or with a velocity of 14.8 ft. per sec., to a depth of approximately 40 ft., the pontoon and discharge pipe rising as the experiment progressed. The specific gravity of the harbor water was 1.015, and the velocity of its current, as observed by submerged floats, averaged: 0.45 ft. per sec. at a depth of 3 ft.; 1.03 ft. per sec. at a depth of 20 ft.; and 2.85 ft. per sec. at a depth of 50 ft.; from which the mean velocity at the point of discharge was taken as 2.2 ft. per sec.

In spite of these large volumes no evidence of the discharge was observed in either case, although it had been detected once before in one of the smaller experiments at this point and at the same depth. The inference was that diffusion occurred rapidly due to subsurface currents at the time of the larger experiment, and that the rise of sewage to the surface probably depends more on the velocity of such currents than on the volume of sewage discharged.

Table II—Diffusion in Waters of Different Salinity*

Liquid added		Top water	Sewage	Sewage
Dilution of uranine solution		1:100	1:1,000	1:10,000
Specific gravity of liquid added		1.000	1.001½	1.001½
Percentage of sea water	Percentage of tap water	Diffusion apparently took place between		
100	0	2 and 24 hours	6 and 48 hours	
75	25	2 and 24 hours	6 and 48 hours	Not complete at end of week
50	50	2 and 24 hours	6 and 48 hours	56 hours
25	75	5 min. to 2 hours	6 and 24 hours	48 hours
0	100	At once	At once	Few minutes and 1 hour

*Experiments by Dr. Payne B. Parsons, Bacteriologist, Metropolitan Sewerage Commission of New York.

Table III—Effect of Depth on Percentages of Sea Water and Dissolved Oxygen Near Sewer Outlets in Boston Harbor, Massachusetts

Date, 1911	Distance from outlet, in feet	Outlet	Depth below the surface, in feet	Percentage of sea water	Dissolved oxygen percentage of saturation
August 29	10	Deer Island	1	68	53
			7	89	88
August 30	90	Deer Island	New surface to 1	80	80
			2	88	95
			3-60	94	100
September 6	1,000	Moon Island	New surface to 1	82	73
			1	82	75
			2	86	90
			3	88	95
			5	90	98
			10	92	99
			15	94	100
September 7	500	Moon Island	New surface to 1	80	68
			2	86	78
			3	88	88
			5	88	94
			10	90	97
			20	92	100
September 11	1,000	Moon Island	New surface to 1	78	68
			2	82	76
			3	86	87
			5	88	92
			10	92	97
			15	94	100
September 11	4,600	Moon Island	New surface to 1	80	72
			2	84	85
			3	88	92
			5	90	97
			10-20	94	100
September 14	2,000	Moon Island	New surface to 1	82	68
			2	86	73
			3	88	85
			5	90	92
			10	94	97
			15	96	100
September 14	2,500	Moon Island	New surface to 1	84	72
			2	86	80
			3	88	86
			5	90	97
			10	94	100
			15	96	100
September 18	5,280	Moon Island	New surface to 1	86	75
			2	88	82
			3	90	89
			5	90	97
			10	94	100
September 18	1,000	Moon Island	New surface to 1	82	68
			2	86	74
			3	88	85
			5	90	92
			10	92	97
			15	92	97

It is clear that salinity of a body of water receiving sewage is an important factor in its diffusion, as it also is in its oxidation, its effect on precipitation, its decomposition, its general appearance, and its accompanying odors. The sewage of the city of Washington, D. C., discharged in 30 ft. of fresh water in the Potomac River and that of Hamburg, Germany, discharged at a depth of 30 ft. in the Elbe, is difficult to discern at the surface, while that from the Boston and New York outlets forms a field on the surface that is often clearly visible, well defined, and extensive. It was noted in the New York experiments with dyes that the edge of the field on the windward side was most clearly defined, while the more rapid diffusion took place on the leeward side.

From what has been said it is evident that diffusion is promoted by locating inlets in deep water of low salinity, but having a high velocity of flow. Discharge should be horizontal and from multiple outlets. The submerged outlets from Deer Island in Boston Harbor, with fourteen horizontal orifices, and the one hundred and fifty outlets of the Passaic Valley Sewer, in which the upward-flowing stream is dissipated by spiral flanges, are excellent examples of effective diffusion and dilution of an effluent in salt water.

As the visibility of sewage fields in calm weather is largely due to the oily surface film known as "sleek," it is obvious that for the sake of appearance, oily wastes should be kept out of effluents so far as practicable: First, by control and treatment at the source of industrial wastes of this nature; second, by providing municipal collection of crankcase wastes from garages; and, third, by installing skimming tanks on the line of outfall sewers. Other points that might be emphasized are the very great effect of turbulence of current on diffusion, and the variable effect of winds on the shape and extent of the sewage field.

Table III shows how the sewage discharged at the Deer Island and Moon Island outlets in Boston Harbor concentrates near the surface, as indicated by the increasing salinity or percentage of sea water and saturation with dissolved oxygen with increasing depth.

Acknowledgment.—The foregoing is a discussion in the September, 1929 Proceedings of the American Society of Civil Engineers.

Pipe Line Bridges; Methods of Covering Pipe and Costs

In the last two years the progress made in the installation of water mains in the Baltimore County Metropolitan District of Towson, Md., necessitated the crossing of three railroad right-of-ways, which were spanned by highway bridges, and due to the fact that the railroad company's and highway's engineers refused to grant permits for the installation of these water mains on the floors of the existing bridges, separate trusses were constructed to carry the mains across. In a discussion at the 1929 conference of the Maryland Water and Sewerage Association A. F. D. Domenics gave the following information regarding this work.

Table I

	79-Ft. Span	126-Ft. Span*	96-Ft. Span
Size pipe, inches	10	10	12
Type of covering	Box and Saw-dust	Box and Saw-dust	Felt and Galv. Iron
Cost of truss and extra steel	$ 846.56	$1,518.69	$1,425.00
Piers	----------	----------	487.50
Cost of laying pipe	30.02	62.40	195.84
Cost of covering	178.86	171.60	499.86
Total cost of job, exclusive of pipe and fittings	1,055.44	1,752.69	2,608.20
Cost per foot, dollars	13.36	13.91	27.16

*The actual length of this truss is 66 ft., although the total length of the crossing is 126 ft. Three brackets were placed 5 ft. apart on the side of the existing highway girder, so as to carry the pipe projecting from each end of the truss.

The Trusses.—The trusses that were accordingly designed and built were of the Warren Type, and were 79, 66 and 96 ft. in length. The first two mentioned were built and hauled to the site and placed on the existing abutments in one piece, but the latter, due to its length was hauled to the site in two sections, and was riveted together in the field and placed in position in one piece. The water mains on these trusses rest on 2x12x¾-in. plates placed equally along the span and are bolted on these plates by ¾-in. U-bolts. To safeguard against any overturning effect, the 66 and the 79-ft. trusses were attached to the existing highway bridges by five straps, three on top chord and two on bottom. These straps were riveted onto the truss, but on the existing bridges the holes on the straps are slotted and bolted to the structure. The reason for slotting is to transmit as little vibration to the truss as possible and at the same time hold the truss in place. The pipe fittings at both ends of the trusses are held secure from blowing out by pipe clamps. Lead was used for jointing material on the three jobs, and there also was placed a sleeve near the center of the crossing to provide for expansion and contraction in the main.

Protecting Pipe from Freezing.—Two methods of protecting pipe from freezing have been used by the department. The first is by encasing the pipe in a wooden box with saw-dust. The box coverings are built as follows: Frames made of 2x4-in. studdings are placed 3 ft. apart around the pipe. On the sides of these frames are nailed 1-in. boards and on the bottom 2-in. boards; this forms the box. The box is then filled with saw-dust, so that, the pipe has at least 4 in. of the material on sides and bottom. The cover is made of 1-in. lumber and then the entire box is covered with asphalt roofing paper, in order to keep the rain from seeping in and wetting the saw-dust.

The second method used is as follows: The pipe is covered with two layers of 1-in. hair felt, each layer firmly secured with copper wire. Between each layer of hair felt is placed roofing or asphalt paper. On the last job (on a bridge crossing a stream), the asphalt paper was sewed on to the hair felt and a great deal of time and labor was saved in placing this around the pipe. A metal casing of galvanized sheet iron is then placed around the pipe and this is held in place by ⅛-in. steel bands 1½ in. wide placed 2 ft. apart. The entire casing is then given two coats of paint to conform with the color of the bridge. Although the saw-dust method is much cheaper and answers the purpose, it is believed that the latter method is more satisfactory and the appearance of the complete job is much neater.

The cost of these jobs complete, exclusive of cost of pipe and fittings, is shown in Table I.

Marginal Lands for Impounding Reservoirs

In a discussion by W. H. Dittoe and G. Gale Dixon, respectively chief engineer and deputy chief engineer, the Mahoning Valley Sanitary District of Youngstown, O., in Vol. 93, 1929 Transactions of the American Society of Civil Engineers, the following table showing the acquisition of land about various important reservoirs is given:

Width of Marginal Lands Acquired About Various Impounding Reservoirs

Reservoir	Land acquired, in acres	Area flooded, in acres	Ratio of land acquired to area flooded	Length of shore line, in miles	Mean width of marginal strip, in feet
New York, N. Y:					
Ashokan	15,222	8,180	1.86	40	1,450
Kensico	4,500	2,218	2.03	30	630
Schoharie	2,372	1,145	2.07	16.5	610
Boston, Mass.:					
Wachusett	5,163	4,200	1.23	35	230
Providence, R. I.:					
Scituate	12,547	3,600	3.5	38	2,150
Akron, O.:					
Rockwell	2,065	769	2.7	20	535
Columbus, O.:					
Griggs	452	363	1.2	----	65
O'Shaughnessy	1,159	829	1.4	----	250
Youngstown, O.:					
Milton	3,344	1,657	2.0	23	606
The Mahoning Valley Sanitary District, Ohio:					
Meander Creek (proposed)	5,248	2,010	2.6	40	690

High Manganese Effluents from Idle Filters

Experimental Work at Columbia Heights Filtration Plant Shows That Manganese Is Redissolved from Sand of Idle Filters

By A. C. JANZIG and I. A. MONTANK

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IN reviewing the analytical data for the past 2½ years at the Columbia Heights filtration plant, we found that the monthly composite samples of the plant effluent yielded manganese, in several instances, in amounts ranging from 25 to 200 per cent greater than that found in the raw water samples. Although these amounts were far below the tolerable limits, the increase was such as to suggest another source of manganese. Since the raw water contained relatively small quantities of the element, it seemed logical, to assume that some stage in the treatment of water was responsible for the increase of manganese. Because it is well known that manganese is deposited and retained on the sand grains of filters this seemed the most probable origin of its increase.

In this work we are dealing with a source of contamination in the plant effluent brought about by the resolution of the manganese oxides from the sand grains of idle filters. This condition is possible even though a raw water supply may contain only small quantities (less than the tolerable limits) of manganese compounds; because a gradual accumulation of the element takes place in filter beds where it may again be redissolved when conditions become favorable.

Experiments at Columbia Heights Filtration Plant.—The Columbia Heights filtration plant contains two sets of rapid sand filters. Filters numbered 1 to 16, inclusive, are as a general rule in service a greater part of the time, while the set of filters numbered 17 to 24, inclusive, have been used only in cases of emergency during the past two years. The latter filters had been out of service for many months and were utilized as a means of determining the extent to which manganese redissolves from the filter beds while in contact with wash water over a period of time. While remaining idle, the filters 17 to 24, inclusive, were washed periodically, about once every month during the winter months and more frequently during the warmer weather. During the month of May they remained idle, in contact with about 20 in. of wash water covering the surface of the sand. Twenty-five samples of water taken from the surface of these filters (about 1 in. above the sand) had a manganese content greatly exceeding the tolerable limits

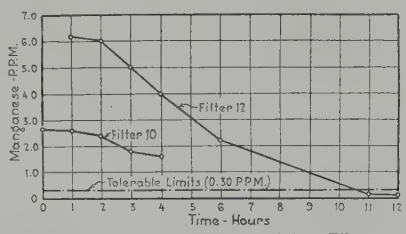


Fig. 1—Manganese in Effluents of Two Filters Idle 38 Days and Operated at a Rate of 1.5 M. G. D.

and in one sample 15.0 p.p.m. manganese were obtained. Four of the filters had been treated with 2 p.p.m. copper sulfate in order to check the growth of algae which had been troublesome in the past. In Table I the results obtained from these four treated filters, are compared with four untreated filters. It will be noted that the treated filters gave a lower manganese content than the untreated filters.

An additional matter of interest in this connection was to determine to what extent biological action influenced the dissolved oxygen content and the hydrogen-ion concentration. The water as applied on these filters had dissolved oxygen content of from 7.0 to 8.0 p.p.m. and an initial pH of 6.7. After the 31-day idle period samples of water from 3 filters gave zero dissolved oxygen, while the samples from the remaining five gave values below 1.5 p.p.m. The hydrogen-ion concentration changed to a minimum of pH 7.1 and maximum of pH 7.6.

The next problem was to determine whether or not a filter which had remained idle and then washed would deliver manganese when placed into service. Hourly samples were taken from the effluents of two filters that had been out of service five weeks and were analyzed for their manganese content. The results obtained, as indicated in Fig. 1, show that these filters delivered water with a manganese content far in excess of the amounts delivered by filters in regular service. It will also be seen that the curves represent values greatly exceeding that of the tolerable limits.

In a series of samples an attempt was made to correlate the manganese content with the degree of reaction that takes place when the o-tolidine reagent is used. Table II shows the extent to which manganese in parts per million is related to the false chlorine readings in parts per million. Samples 2, 4, and 6 vary considerably in manganese concentration, but all apparently react to the same degree with o-tolidine reagent after a 10-minute contact period. Sample 2 exceeds that of sample 5 in manganese content by more than 1.5 times, yet the same amount of false chlorine is produced by both. In a comparison of sample 1 with sample 8, it is noted that a difference of 30 times in the manganese content exists while the difference in the false chlorine obtained amounts to only 7 times. The 50-minute contact period with the o-tolidine reagent gave values from 0.01 to 0.04 p.p.m. higher than that of the 10-minute period. However, one sample failed to show an increase of false chlorine.

Discussion.—Early investigators have attempted to explain the deposition and resolution of manganese in filter sands on the basis of physico-chemical action rather than by biolysis. Able support of the biological theory in bringing about a change of manganese from the soluble to the insoluble form and vice-versa, is presented by the independent work of Baylis and Kühr. Baylis demonstrated by laboratory experiments that the deposited manganese on sand will redissolve. He used samples of sand taken from filter beds which were covered with slime produced by bacterial growth, and submerged them in water for a week or more. The solution obtained from this sand contained about 10 p.p.m. soluble manganese. He repeated this experiment a number of times, and in every case when the sand was covered with slime there was an increase of soluble manganese. He considers that in covering the deposited manganese with slime, the bacteria

Table I—Manganese in Surface Samples from Treated and Untreated Idle Filters. Results in Parts per Million

Treated Filters*		Untreated Filters	
Number of bed	Manganese p.p.m.	Number of bed	Manganese p.p.m.
17	1.0	18	4.5
19	3.8	20	15.0
21	1.5	22	3.8
23	1.0	24	6.0

*Treated with 2 p.p.m. copper sulphate.

Table II—Comparison of Manganese in Parts per Million with False Chlorine Produced in the Sample*

Sample	Manganese p.p.m.	False Chlorine 10 minute contact p.p.m.	False Chlorine 50 minute contact p.p.m.
1	15.0	0.07	0.10
2	6.0	0.04	0.06
3	4.5	0.08	0.12
4	3.8	0.04	0.04
5	3.8	0.04	0.07
6	1.0	0.04	0.07
7	1.0	0.03	0.05
8	0.5	0.01	0.02

*Using o-tolidine made according to Standard Methods, 1925 edition.

produce conditions favorable for its being thrown into solution. Kühr, on the other hand, gives experimental evidence that manganous compounds can be oxidized to manganese dioxide by microbial growth. He demonstrated this fact by inoculating the surface of a solid, synthetic media containing manganous carbonate with bacteria and fungi as found in raw dune water and in the mud of rapid sand filters. The cultures developed a typical dark brown manganese dioxide. He concludes that "by the biological oxidation process the dissolved manganous compounds can be transformed into undissolved manganese dioxide, and that inversely by biological reduction, which always takes place in anaerobic processes, undissolved manganic compounds can pass into dissolved ones."

The fact that soluble manganese is retained as manganese oxides in active filters and redissolved in idle filters is supported by the results obtained in the experiments conducted. Soluble manganese found in 25 samples of water taken from the surface of idle filters seems to confirm the biological resolution theory, and the negligible amount or absence of manganese in the effluents of filters in regular service adds evidence to the known fact that retention of manganese compounds as insoluble manganese oxides occurs on sand grains. In Table I a comparison is made between the amount of soluble manganese obtained from a set of treated and a set of untreated filters. Probably this difference would have been even more marked had the treated filters received frequent and larger doses of copper sulfate. This phase of the subject will require further study in order that more definite and complete information can be secured. A suggestion is also seen for further investigation in the use of other sterilizing agents which would be applicable for filters out of service. If no subsequent operating difficulties arise another means of preventing the resolution of manganese may be found in permitting filters to remain dry during their idle period.

The conditions were favorable for anaerobic decomposition in the water on these idle filters is evident since the dissolved oxygen content in five filters was very low, and in three of the filters it was zero. Originally the applied water had a dissolved oxygen content of about 7.5 p.p.m. The logical deduction to be drawn here is that the depletion of oxygen was due to aerobic biological activity, since the loss of oxygen can be explained in no other way. Another condition probably brought about by biological action is the change found in the hydrogen-ion concentration from a pH of 6.7 in the applied water to an average of about 7.3 at the end of the 31-day period. It is possible that the end products of anaerobic decomposition increased the pH above the neutral point, as it is known that ammonia may be evolved from such decomposition. It would seem, therefore, that the resolution of manganese did not take place because of the presence of an acid condition.

The most interesting observations made are those represented by Fig. 1 showing the delivery of soluble manganese from two filters, 10 and 12, which had been idle for more than five weeks. The filters had been thoroughly washed and filtered to waste for 15 minutes before being put into service. At a filtration rate of 1.5 million gallons per day, the effluents of these filters continued high in manganese concentration over a period of several hours. Five samples were taken from filter 10 and analyzed. It delivered an initial manganese concentration of 2.7 p.p.m. Out of the seven samples analyzed from filter 12 the initial sample showed manganese to the extent of 6.2 p.p.m. In the latter filter, a sample analyzed after the second hour showed a slight decrease of manganese, and the subsequent hourly samples showed approximately 1 p.p.m. decline in the manganese content. A normal condition with respect to manganese was not obtained until a period of more than 11 hours had elapsed. The initial yield of manganese for filter 10 is only about one-half that of filter 12. Although more samples should have been taken from filter 10, it would seem from the curve plotted and also by interpolations that the period of time necessary for this filter to reach a normal output of manganese would be at least 8 hours.

In addition to the samples from the two filters shown in Fig. 1, one sample was obtained from filter 9, which had been out of service 42 days. This filter yielded a manganese content of 0.40 p.p.m. after it had been in operation nearly 7 hours. The delivery of a high manganese content does not result from filters which are in continuous operation, as evidenced by the analysis of the effluents of normal filters. The average manganese content of these filters, during the same period of time, rarely exceeded 0.05 p.p.m., and approximately 50 per cent of the time was zero.

Since the effluents of the idle filters delivered such an excessive amount of soluble manganese, it was desirable to know whether or not the plant effluent would show an increase over the monthly average. The monthly composite samples of the plant effluent for the years 1927 and 1928 gave a maximum manganese content of 0.06 p.p.m., a minimum of 0 and an average of 0.02 p.p.m. Two samples of the plant effluent were taken at about 22 and 29 hours after filters 10 and 12 were put into operation. It was calculated that sufficient time had elapsed to allow for a detention period in the clear water reservoir so that a representative sample could be secured. Analysis of the first sample, taken after 22 hours, showed a manganese content of 0.10 p.p.m. and of the second, at the end of 29 hours, of 0.08 p.p.m. While these figures do not represent amounts that are likely to cause trouble, it can be seen that a potential danger exists when a number of idle filters are put into service at the same time.

The reaction of manganese compounds with the o-tolidine reagent produces the characteristic color that free chlorine produces with the same reagent. In Table II no direct relationship was found to exist between the amount of manganese in parts per million and the amount obtained in false chlorine readings. Campion at the Barberton plant in Ohio gives experimental evidence to show that false chlorine readings reach their maximum value when the oxidation of manganese has gone to completion. Apparently the degree of oxidation in which the manganese exists is a factor in the production of the yellow color with o-tolidine. This may explain the lack of correlation in the values tabulated in Table II. Forsberg made the interesting observation that "Water containing manganese as manganic hydroxides gives the same reaction with o-tolidine as chlorinated water, irrespective of whether a water, alcohol, sulphuric acid or hydrochloric acid solution of the reagent is used." Aside from the deduction made from Table II, a point of interest is found in the fact that the majority of the false chlorine readings produced by manganese compounds increased with time, while on the other hand it is a well known fact that in the test for free chlorine the converse is true.

From a consideration of the bio-chemistry of the subject the deductions are that the deposition of manganese is caused by a biological oxidation process; and inversely, the biological reduction induced by anaerobic decomposition converts manganese oxides into the soluble manganous compounds. The layer of manganese oxide deposit formed on the sand grain serves to attract more soluble manganese, which in turn is oxidized by the aerobic microbes to the insoluble form. The process is continued until finally the sand grains are covered with many layers of manganese oxide.

In the case of incrustations formed on the sand grains of filters where alum is used as a coagulant, there exists, in addition to an insoluble manganese oxide and bacterial jell, aluminum hydroxide. The two latter substances may occur in intimate combination with the manganese oxide, or they may occur in alternate layers with the manganese oxide. The writers believe that when anaerobic decomposition has rendered the manganese oxide soluble, the coatings of bacterial jell and aluminum hydroxide probably act in a manner similar to that of a semi-permeable membrane, delaying the rate of diffusion of soluble manganese from the sand grain. It is therefore reasonable to suppose that, when a filter is washed, only the outer soluble manganese com-

pounds are rapidly removed. Following this reasoning it is probable that after the filter is placed in service, the hydrostatic pressure created is sufficient to draw the soluble manganese out from the inner layers of the same grain. This explanation may account for the delivery of a high manganese content over a period of 8 hours or more by idle filters which are again put into service.

Summary.—Analytical data are presented to show that manganese is redissolved from the sand of idle filters.

It is demonstrated that the effluents of idle filters will deliver a high concentration of soluble manganese, and that this condition may continue for a number of hours.

No direct relationship is found between the amount of manganese present in a water and the amount of false residual chlorine produced with o-tolidine reagent.

The information obtained thus far indicates that biological action is an important factor in the process of redissolving manganese.

A suggestion for the prevention of the resolution of manganese in idle filters may possibly be found in the proper use of copper sulfate.

Acknowledgment.—The foregoing is an abstract of a paper presented June 14 before the Minnesota Section of the American Water Works Association.

Contamination by Consumers' Water Uses

A New Viewpoint of Possible Water System Pollution

By S. B. MORRIS
Chief Engineer, Water Department, Pasadena, Calif.

IN reviewing water works literature, I do not recall any papers having been presented or restrictions drawn regarding piping and use of water by consumers after water has passed through the meter to their private premises. Before discussing the general possibility of such contamination, I should like to recite a few instances of contamination which have come under my observation.

How Lime Got Into the Mains.—One day we received a complaint of excessive lime in the water of a limited district. Upon investigation we found that a water softening plant where water was treated for boiler feed purposes, was the cause of trouble. An elevated tank with pressure normally much less than that on the public water system stored this heavy dose of lime. During an emergency shutdown of the water main, a check valve on this line failed to operate and the lime water contents of this tank was drawn into the distributing system.

Cafeteria Has Connection with Swimming Pool.—In another instance, we received complaint at a school cafeteria that excess chlorine in the water was discoloring the silverware. We knew this could not be the case, as the territory involved received no chlorinated water. Upon investigation, we found that an ortho-tolidin test showed about one-tenth part per million of free chlorine at the cafeteria, whereas a test from a fire plug directly connected to the city main adjoining the school showed no free chlorine. It was apparent that the cafeteria was receiving its water from a connection to the swimming pool circulation line, which proved to be the case. Apparently a serious epidemic was only averted by continuous excess chlorination of the swimming pool water.

Sewage Backs Up Into Domestic Water System.—At another time, we received complaint of sewage odor in the showers at a public swimming pool. We immediately investigated and found the complaint justified. There was a sewage pumping plant about 500 ft. from the swimming pool. At this plant horizontal, centrifugal pumps were used with automatic, intermittent operation raising the sewage from a concrete storage well up to the public sewers about 100 ft. higher in elevation. The sewage pumps were located above the elevation of the sewage in the storage well necessitating pumps operating under a suction. The pump operator had had so much difficulty in priming these pumps that he installed a hose connection between a garden valve connected to the public water supply and used this hose to prime the pumps. Finally he had wired one end of this hose to a stop cock on top of the pump. At the time of the complaint, he had forgotten to close the stop cock and the pressure on the sewage pump line being in excess of the domestic water supply, caused accrued sewage to back up into the domestic water system actually contaminating the shower baths at the swimming pool.

How Air Got Into the Water.—In another instance, we received complaints of air in the water over a considerable area. For several months we were unable to discover the source of air the consumers complained of. Finally, we found a water meter which registered backwards. Investigation showed that the machine shop and garage furnished by this service had an air compressor and air storage tank. In order to diminish the water bills, the proprietor of this shop had blown water back through the water piping, reversing the water meter while the air passed off into the water distributing system. Probably no contamination occurred through this operation, but it illustrates the possibilities of water being passed through the meter into the distribution system.

From time to time new industrial or sanitary equipment offering opportunities of contamination comes upon the market. The water utility has no direct knowledge of what equipment or piping is being installed by the individual consumer within his private premises. How is this matter to be controlled? I believe the only way is by co-operation with the building and plumbing inspection departments of the city.

Acknowledgment.—The above is an abstract of a paper presented Oct. 24 before the California Section of the American Water Works Association.

Sanitation Department Urged for New York City

The Merchants Association of New York City has opened a campaign in behalf of the proposed charter amendment which would create a new city department of sanitation for the city of New York.

Action by the association followed a study of the subject by the organization's committee on sanitation, public health and water supply, of which Prof. Olin H. Landreth is chairman. Letters were sent to thirty-eight other organizations. They declared in part:

"The measure relates to a vital matter—the health of the people of New York. The planning of adequate and comprehensive sewage and garbage disposal systems which will free our rivers and beaches from the filth with which they are now polluted, and thus rendered a menace to the thousands who use them, is one of the gravest problems faced by our city. Attempts to deal with this subject in the past have been fruitless of any large accomplishment.

"The state of New Jersey has recently instituted with the Federal government an action to prevent the dumping of garbage at sea—alleged to be a contributing cause of pollution affecting not only the New York but also the New Jersey beaches. The work of providing adequate disposal plants in order to anticipate the intolerable situation which might arise if the Federal government should put a stop to this practice should be speeded up.

"Sanitation experts and others who have studied this matter believe that existing agencies are inadequate to deal with the problem. Those who have given most thought to the subject are in agreement that the creation of a department of sanitation, such as is now proposed, offers the greatest expectation of obtaining expeditiously a sound and comprehensive plan of relief."

Sewage Sludge as Fertilizer

Sludge from Present Sewage Plants Could Furnish 8,000 to 10,000 Tons of Nitrogen Yearly

By WILLEM RUDOLFS

New Jersey Agricultural Experiment Station, New Brunswick, N. J.

HUMAN wastes and wastes from certain industrial processes contain considerable quantities of plant-food, which under ordinary conditions are lost. If the sewage is not treated, the material finds its way into streams and water courses; and in those cases where sewage disposal plants are present, the organic solids are retained as a sludge.

There are two general methods of sewage purification; namely, settling of solids followed by anaerobic digestion, and oxidation by forcing air into sewage. In both cases quantities of sludge are left behind. The sludges contain appreciable quantities of nitrogen and some phosphorus and potash, but the chief value of the sludge for fertilizer is in its nitrogen content.

There is at present only one sewage disposal plant in this country—the Milwaukee activated sludge sewage plant—where sludge is commercially marketed on a large scale. In a number of instances the sludge is locally sold for a nominal sum to farmers in the neighborhood. In the majority of cases the sludge is either buried or used for filling-in low places.

Composition of "Milorganite".—The product sold by Milwaukee under the trade-name of "Milorganite" has been dried, finely and evenly ground, and contains 5 per cent or less moisture.

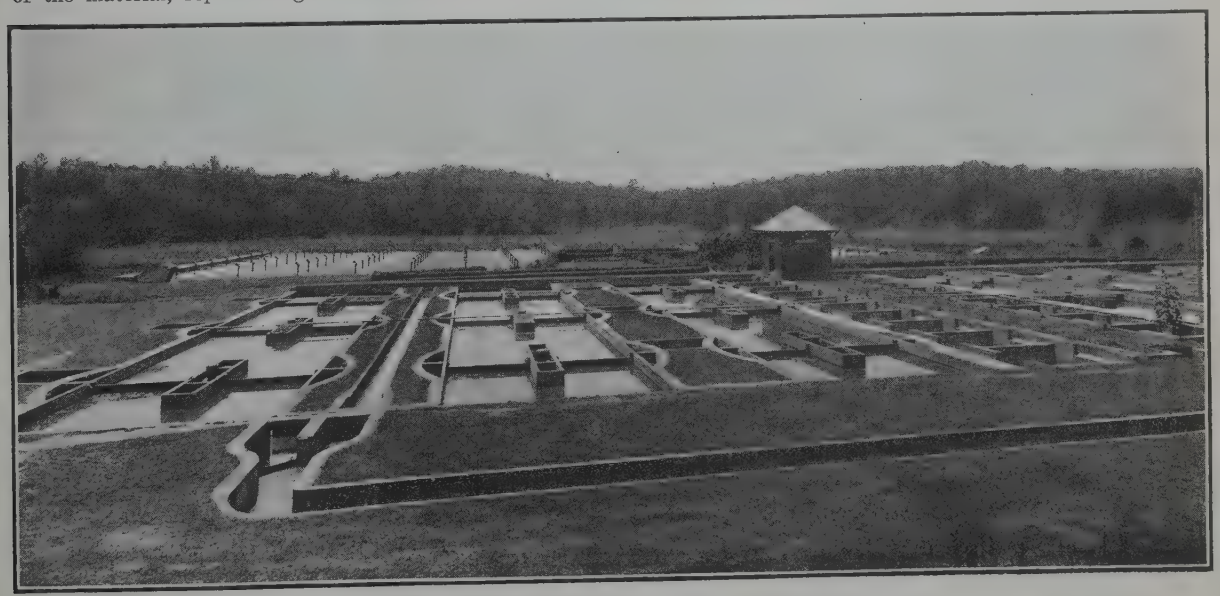
Kadish (2) has published an analyses of the material, representing 145 carloads shipped during a part of 1927. The composite sample contained:

	Per Cent
Total nitrogen	5.42
Water soluble organic nitrogen	0.30
Nitrogen insoluble in neutral permanganate	0.71
Active nitrogen by alkaline permanganate	3.22
Total phosphoric acid	3.08
Available phosphoric acid	2.43

Analysis of Plainfield Sewage Sludge.—There are only a few activated sludge sewage disposal plants in the country as compared with disposal plants where the sludge is digested anaerobically. Sewage sludge looses part of its nitrogen content in the course of digestion, probably most of it as nitrogen gas. As examples of the fertilizing value of fresh (undigested) solids, partially decomposed material, and fairly well-digested sludge, analyses of material obtained from the Joint Sewage Disposal Plant of Dunellen, Plainfield, and North Plainfield, N. J., are given in Table I. The analysis used for illustration show a rather high initial total nitrogen content. It usually runs at this particular plant between 3.50 to 4.00 per cent nitrogen. An average of a number of analyses shows 3.62 per cent total nitrogen in the fresh solids and 2.70 per cent in the ripe (digested) sludge.

Analysis of Sludge from 14 Cities.—At the request of the author, a number of superintendents and engineers in charge of sewage disposal plants in the country forwarded samples of sludge to our laboratory for analysis. The pertinent results together with some remarks are given in Table II. The percentage ash of the materials varies considerably. There are two reasons for this variation; namely, inorganic trade wastes present in the sewage, and the degree of decomposition accomplished. Domestic wastes settling out at a sewage treatment plant contain from 20 to 25 per cent ash. These solids, kept for a considerable number of days in digestion tanks, decompose under anaerobic conditions, producing large quantities of methane, some carbon dioxide, and some nitrogen gases (CH_4, 70 to 75 per cent; CO_2, 18 to 25 per cent; N, 3 to 10 per cent). The amount of ash remains constant but the percentage increases in relation to the percentage decrease of organic matter, with the result that well-digested sludge contains approximately 50 per cent ash. When inorganic trade wastes are received, the initial ash content varies from 25 to as high as 50 per cent, according to the amount of trade waste present.

The nitrogen content of the sludge depends upon the same two factors. The better digested, the lower the nitrogen content; and the more trade waste, the less the original percentage nitrogen, except when slaughterhouse, tannery, and such wastes are treated. If less than 2.5 per cent total nitrogen is present in the digested sludge there



Intrenchment Creek, Sewage Disposal Plant, Atlanta, Ga.

is ordinarily inorganic trade waste present.

The sewage plant operator wishes to produce a well-digested material, because this material will dry rapidly and has no odor, but in doing so, the fertilizing value of the sludge decreases.

The amount of dry domestic solids produced per capita per day is fairly constant. A large number of analyses shows it to be in the neighborhood of 70 gm. per capita daily. With trade wastes present the amounts rise sometimes as high as 200 gm. per person per day. The amount of solids retained at a domestic sewage treatment plant varies from 30 to 65 gm. per capita per day, depending upon the type of treatment plant. In the aggregate the quantities of sludge produced are enormous. Milwaukee alone, for instance, produces approximately 25,000 tons of dry sludge, which must be handled in a wet condition, requiring machinery to treat 500,000 tons sludge. Where the sludge is digested, the quantities are lower. Fuller and McClintock (1) state that at present about 15 per cent of the sewage is treated in this country. The total dry solids in the sewages received at these plants is between 400,000 and 500,000 tons per year. Assuming a minimum average of 2 per cent nitrogen in the sludge, the annual loss of nitrogen amounts to from 8,000 to 10,000 tons for the treated sewage only. Most of this could be used as fertilizer, since it is already collected at sewage disposal plants.

From 150,000 to 200,000 tons of nitrogen, as a conservative estimate, present in sewage is annually lost by discharging sewage into streams and water courses, and by wasting the sludges.

Summary.—The nitrogen content of sewage sludges varies with the type of treatment. Aerobically treated sewage sludge contains about 5 per cent, and anaerobically treated sludge averages about 2.25 per cent nitrogen. Only one sewage treatment plant markets its sludge on a large scale; at a number of places the sewage sludge is given away or sold for a small nominal sum. It is estimated that from 150,000 to 200,000 tons nitrogen is lost annually. Based upon analysis of a number of sludges from different sewage plants,

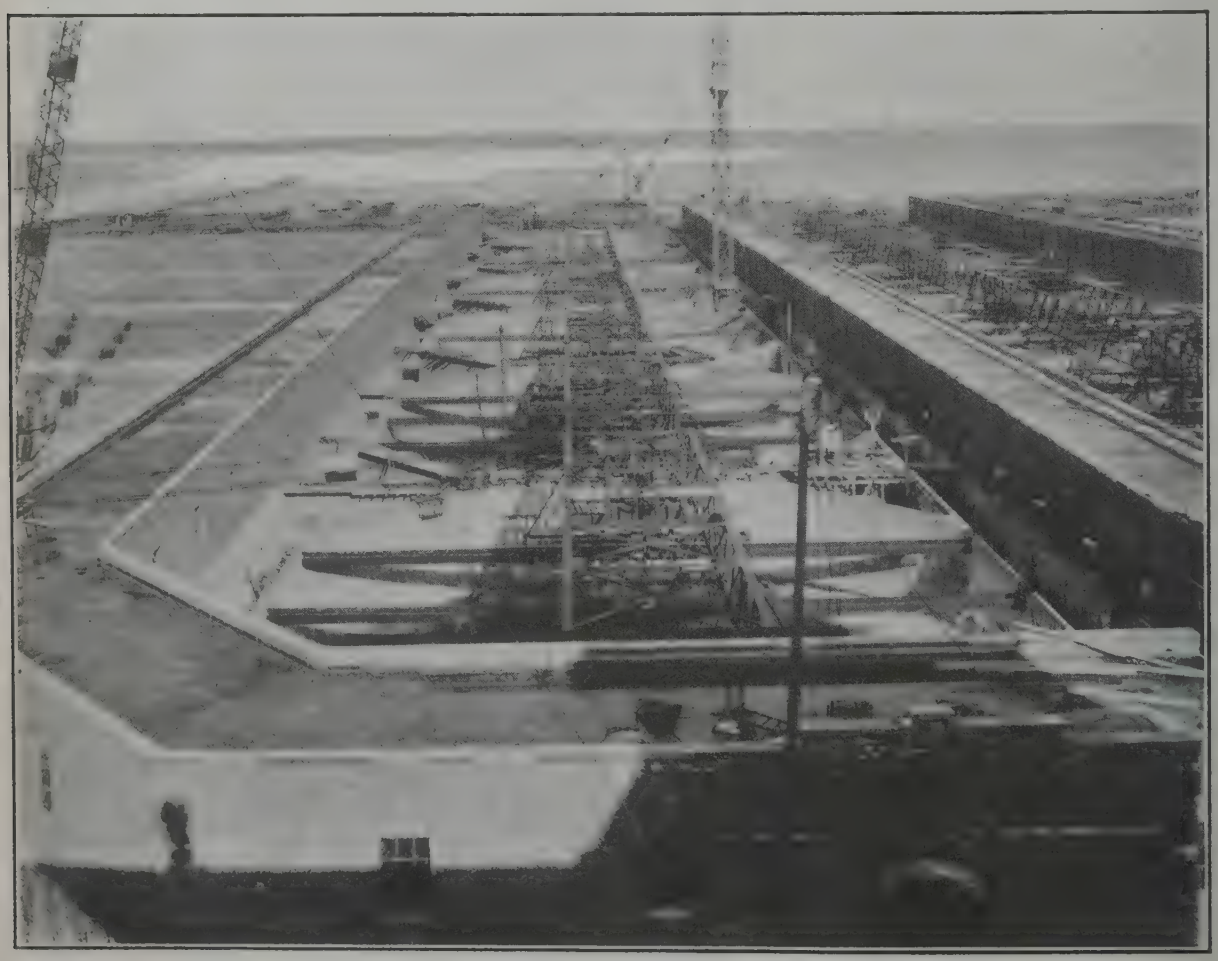
Table I—Analysis of Plainfield Sewage Sludge

	Fresh solids, per cent	Partly digested solids, per cent	Fair digested solids, per cent
Total N	4.81	3.98	3.55
Insoluble N	4.14	3.61	3.41
Soluble N	0.67	0.37	0.14
NH_3-N	.....	.....	0.09
Soluble organic N	.....	.....	0.05
Active insoluble N	0.98	1.89	1.57
Inactive insoluble N	1.16	1.71	1.84
Ether extract	15.11	7.79	6.83
Crude fiber	6.01	5.55	5.50
Ash	25.70	37.90	42.62

Table II—Analysis of Sludge from Different Disposal Plants

Place	Total N, per cent	Ash, per cent	Degree of digestion
Trenton, N. J.	1.18	51.7	Good
Rochester, N. Y.	1.96	59.1	Good
Schenectady, N. Y.	1.86	56.9	Fair
Schenectady, N. Y.	1.97	44.1	Poor
Fort Worth, Tex.	2.77	31.5	Poor
Fort Worth, Tex.	2.07	48.4	Fair
Marion, O.	2.70	48.1	Fair
Marion, O.	2.49	46.9	Good
Baltimore, Md.	2.48	32.1	Poor
Baltimore, Md.	2.18	50.5	Good
Portsmouth, O.	0.63*	81.9*	Much sand
Chambersburg, Pa.	2.53	33.2	Poor
Mount Alto, Pa.	1.70	41.2	Fair
Lebanon, Pa.	2.68	40.4	Fair
Worcester, Mass.	2.97	36.9	Fair
Chicago, Ill.	1.67	58.4	Good
Antigo, Wis.	2.09	55.2	Good
Plainfield, N. J.	3.16	37.2	Fair
Plainfield, N. J.	2.56	49.8	Good
Average	2.28	45.4	

*Left out of average.



Sewage Treatment Plant at Milwaukee, Wis., During Construction

it is estimated that from 8,000 to 10,000 tons nitrogen per year could be saved at present.

Acknowledgment.—The above is a paper of the Journal Series of the Department of Sewage Disposal of the New Jersey Experimental Station. It is reprinted here from Soil Science.

(1) Fuller, G. W., and McClintock, J. R., 1926. Solving Sewage Problems. New York.
(2) Kadish, V. H., 1928, Milorganite—A new fertilizer material. Indus. and Engin. Chem. 20:9-10.

Sewage Plant Operations at Milwaukee

The following notes on the operation of the activated sludge plant of Milwaukee, Wis., are taken from the recently issued 1928 report of the common council on the activities of the city departments, boards and commissions:

Throughout the year 1928 the sewage disposal plant was operated at its full capacity. At the beginning of the year, the average amount of sewage treated was 85,000,000 gal. for 24 hours. Due to additions mainly in the suburban sewer system, the quantity treated rose during the year to an average of 95,000,000 gal. per 24 hours. During each day there is a peak load on the plant which amounts to from 130 to 140 million gallons in 24 hours.

During 1928 the total time of bypassing due to storms was 7.8 per cent of the total number of hours per year. Therefore, 92.2 per cent of all the sanitary sewage produced in the metropolitan district during the year was purified, the balance being taken care of by dilution in the large basin of Milwaukee bay.

Sales of Fertilizer.—The plant removes from the sewage all the suspended solids, which are converted into a commercial fertilizer and sold. The total output of the plant during the year amounted to 33,000 tons of fertilizer for which approximately $600,000 were received.

The demand for Milorganite, the fertilizer produced in the sewage disposal plant, has always been greater than the supply. About 70 per cent of the output is shipped to fertilizer manufacturers who blend it with other ingredients such as phosphates and potash and sell this product for use mostly in the states that grow cotton and tobacco. The remaining 30 per cent is sold for use directly without the admixture of any other material. This unmixed Milorganite is especially valuable for the growing of fine lawns and for general garden use. Most of this part of the output goes to golf courses, park boards, and other places where fine lawns are maintained. A considerable amount is sold in 100 pound bags to the gardeners of Milwaukee and the surrounding suburbs. These local sales in 1928 brought a return of approximately $10,000. The retail sale price is $1.50 per 100 lb. bag.

The research work was pursued vigorously during the year and has furnished valuable information which will be used in the plan of the necessary extension. The four small plants in the testing and control station were continually operated, and the results obtained were analyzed and tabulated.

During 1928 an elaborate cost keeping system was worked out which will be put into service at the beginning of 1929. This will make it possible to determine accurately the cost of every phase of plant operation.

The intercepting sewer system was somewhat extended during the year.

Elimination of Odor.—During 1928, the method used in treating odor, introducing chlorine gas into the dryer discharge, proved very successful. Very few odor complaints were received during the year, and these were carefully traced to their source. Some of the complaints were clearly caused by odors emanating from sources other than the sewage disposal plant, but several were found to be well founded and caused by faults in the operation of the dryer equipment. Continued experiments with this equipment has resulted in an almost entire absence of complaints.

When the chlorine treatment of dryer gases was introduced, it was considered only a temporary expedient, and other methods of deodorizing were investigated. It was found that chlorine was superior in its effect to other methods and lower in its operating cost. During the year the total cost of chlorine used for deodorizing was almost exactly $10,000.

Plans for Plant Extension.—The gradual increase in the amount of sewage coming to the plant points to the necessity of plant extension in the near future. Another factor contributing to this is the rapid development of the suburban territory lying within the metropolitan district. It is expected that these plans will mature during the year 1929 and that the necessary building operations will commence during the year 1930.

Uniforms for Meter Readers

A recent regulation of the Hackensack Water Co., Weehawken, N. J., provides that all employees whose duties require them to enter homes of consumers must wear uniforms, according to Nicholas S. Hill, Jr., president of the company. Inspectors, meter readers and collectors will be attired in dark gray whipcord with the initials "H. W. C.," in red, on the right breast, and will wear caps bearing the letters "H. W. C.," also in red. The purpose of the uniforms is to enable customers to identify water company employees, and to guard against unwarranted intrusion of homes by impostors who in the past have not infrequently posed as representatives of the company.

Athens Celebrates Opening of Marble-Faced Marathon Dam

The Marathon Dam, overlooking the immortal battlefield, where in 490 B. C., the Greeks overcame the conquering Persians, and built to provide the city of Athens with an adequate water supply, was officially opened Oct. 25, by the President of Greece, Paul Koundouriotis, according to dispatches received by Ulen & Co., New York City, the builders of the dam. Premier Venizelos and members of his cabinet, and other personages important in Greek governmental circles, as well as the foreign diplomatic body took part in the inaugural ceremony. A general holiday for Athens was declared.

Adequate water supply has always been a problem to the Greek capital, and as far back as 594 B. C. Solon enacted laws governing its consumption. Three years ago, Ulen & Co., signed a contract for the construction of the Marathon Dam and a new acqueduct tunnel 8½ miles through the base of Mt. Pentelikon, and together with the Bank of Athens formed the Societe Anonyme Hellenique des Eaux des Villes d'Athens, Piree et Environs to manage the water system of the city of Athens and Piraeus. The Marathon Dam is the first important step in this project. Through repairs and improvements of the old Hadrian Aqueduct, built 2,000 years ago, the city is now furnished with 14 gal. per capita daily instead of 3½ gal. per capita. During the year 1930 according to the engineers, the new aqueduct will raise the supply to 135 gal. per capita per day.

The dam itself is the gravity section arch type, faced up and down stream with the Pentelikon marble of which the classic structures on the Acropolis are built. It is filled with solid concrete. Measured along the crest, the dam is 935 ft. long, with a thickness at the base of 154 ft. and at the crest 15 ft. Its height above the stream bed is 177 ft. More than 40,000 tons of Portland cement and 10,000 tons of pozzulan cement were used. The reservoir formed by the dam will impound 10,825,000,000 gal. of water, and even if this supply was not added to, it would be sufficient for the needs of Athens for two years.

The water for the reservoir is drawn from the hills above the plains of Marathon and will be conveyed through the tunnel 8½ miles long and then through pressure pipes to the city proper. In order to relieve the meager supply the engineers have also constructed a salt water system which pumps water from the Aegean Sea for the sprinkling of the city streets.

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Is the Boulder Dam Project on Colorado River Premature?

While there is little doubt that a large part of the Colorado River should be conveyed to Los Angeles County and neighboring territory eventually, we are by no means satisfied that work on this diversion should begin at once.

In 1924 the consulting engineers estimated that in 1950 the city of Los Angeles would have a population of 2,180,000, of whom 80 per cent would reside in 60,000 acres having at least 14 people per acre. They estimated that these 1,740,000 people (who will be designated hereinafter as urbanites) would use 130 gal. per capita per day for domestic purposes, plus about 32 gal. additional for industrial purposes. We deduce the 32 gal. from their estimate of 62,500 acre-feet of water annually used industrially in an area of 25,000 acres outside the 60,000 acres of urbanite territory, their estimate being 2.5 ft. of water per acre of industrial land. The combined domestic and industrial consumption of the 1,740,000 people in 1950 was estimated at 316,500 acre-feet, to which was added 248,000 acre-feet for the remaining 20 per cent of the population who will be designated here as "farmers." If the "farmers" used 130 gal. per capita per day for domestic purposes, that would take about 63,000 acre-feet, leaving 185,000 acre-feet for irrigation, or about one-third of the total 564,500 acre-feet used within the corporate limits of Los Angeles in 1950. For the farm districts the engineers estimated 2 ft. of water per acre per year.

Continuing the estimates of the consulting engineers, we have the following "Water requirements of the metropolitan area of Los Angeles County including city of Los Angeles in 1950."

	Acre-feet
Domestic use by "urbanites"	386,000
Industrial use	150,000
Domestic irrigation and other uses by others	823,000
	1,359,000

This last item is rather misleading, for by placing the word "domestic" first it produces the impression that "irrigation" is subordinate in importance, whereas as above shown, about 75 per cent of this item in Los Angeles city is for irrigation. If we take 75 per cent of 823,000 acre-feet as being for irrigation we have 627,000 acre-feet, which is nearly half the total estimated water consumption in Los Angeles county in 1950.

This immediately discloses that the proposed increase in water supply for the Los Angeles district is quite as much a farming project as a municipal project.

We believe that a similar analysis of the proposed uses of the Colorado River water elsewhere in Southern California will disclose that much more than half the water is intended to irrigation. While there is nothing wrong in such a plan, we doubt whether many of the city residents realize that they are being asked to vote bonds that are to be mainly used for developing farms.

Los Angeles county and nearby areas are already great agriculturally, and it may pay to develop them even more intensively, as producers of citrus fruits, grapes, etc. But judging by the wails that have repeatedly come from the growers of those products, overproduction has already made it difficult for them to reap a satisfactory profit. If with water lifts of only 100 ft., a farmer finds his profits small, what will they be when he has to pay for a 1,500-ft. lift over the divide between his farm and the Colorado River?

This is an economic question that we have never heard asked before, but it is certainly one to which both the rural and the urban residents of southern California are entitled to a definite answer.

In an article elsewhere in this issue data are given showing that at least 180 second-feet of additional water can be brought from the Mono Lake basin to Los Angeles. This would supply about 720,000 people with 160 gal. each per day. The cost of securing this additional supply is roughly estimated at $30,000,000.

We shall not be surprised if a study of the water resources of the Mono basin and the Walker River basin to the north of it, will show that 2,000,000 more people can be adequately and economically served from these regions of the eastern slope of the Sierra Nevadas, provided that the water is not used for irrigation but only for domestic and industrial purposes, and provided that none of it is wasted in developing water power at times when it should be stored for future domestic use.

Some years ago the editor appraised the hydroelectric power plants and water rights of the Southern Sierras Power Co. and subsidiaries in the Mono and Owens River regions, and thus gained considerable knowledge of the water resources of that region. He has visited that section many times in recent years. His belief is that the water resources of the Mono basin and the Walker River region to the north, may prove to be great enough to provide for the growth of metropolitan Los Angeles for another decade and still leave time in which to build the Colorado River aqueduct. All this provided that a great irrigational development of the Los Angeles district is not undertaken in the meantime.

As the article on the Mono basin project states, about $30,000,000 will be needed to acquire lands and water rights in that region, and to build reservoirs and aqueducts that will feed the Mono waters into the present Los Angeles aqueduct. While this is a large sum, it is dwarfed by the proposed Colorado River project. A vastly greater sum than $30,000,000 would be justified if the Colorado River project could be postponed 10 years.

The cost of the dam and power plant for that project is estimated at more than $150,000,000 and the aqueduct at about a like sum. Since great projects of this sort usually exceed the estimated cost, it would not be surprising were the entire project to cost $400,000,000 or more. It would seem needless to say that such an undertaking should not be lightly entered upon. Yet thus far it seems not to have had half the engineering study that it calls for, before even deciding to spend $300,000,000, to say nothing of deciding as to how long that construction can be wisely deferred.

We know that a great deal of important surveying and other engineering work has already been done, that many preliminary estimates have been made, and that the project is feasible. But what engineer is willing as yet to stake his reputation on what the project will cost?

In a recently published paper by Mr. R. H. Moulton, of Los Angeles, on "Financing Control of Water," we read: "Los Angeles and Southern California is again faced with a water crisis looking ten years ahead. The only conceivable plan existing at this time to adequately care for the future, will result in the building of the Boulder Canyon Dam by several states and subsidized by the Government, which will cost between $150,000,000 and $200,000,000. In addition to this, the aqueduct must be built several hundred miles, which will cost between $150,000,000 and $200,000,000."

What we wish here to emphasize is the indefiniteness of such cost figures. Between the $300,000,000 and the $400,000,000 there is a spread of $100,000,000, a difference sufficient to build a waterworks system to supply 1,250,000 people in the typical American city. We insist that where such vagueness exists as to the probable cost of a project, a great deal of engineering work remains to be done on it. But almost as important is the necessity of a most thorough study of other projects that may serve to postpone the enormous investment that the Colorado River project will involve.

If it be argued that at least half the investment will be self-supporting through the sale of industrial power, this too calls for careful study. To begin with there is a fair prospect that before the expiration of the bond amortization period of 50 years, there will be no power available except for pumping the water over the "divide." Little enough is known as to the probable rate of silting up of the proposed dam, but that little is ominous.

The Colorado River project is amazingly bold; unquestionably feasible and certain to be carried out eventually. But it is not like the purchasing of certain advertised goods whose makers' cry is, "Eventually—why not now?" To build this project now may be a great mistake, and we contend that until other projects are thoroughly examined it is likely to be a mistake.

We repeat a suggestion that we made several months ago: Many entirely separate groups of consulting engineers should be employed to study all the possible alternatives involved in this very complex problem. The fees of all of them combined will weigh as nothing when contrasted with the saving that some one of them is likely to effect. Parsimony in the hiring of consulting engineers may not account for the prospective abandonment of the San Gabriel dam site after spending $3,000,000 there; but it is fairly certain that had more consulting engineers been employed, some one of them would have pointed out the grave risk of running into unsuitable rock beneath the dam. Months before the rock slide at the dam occurred, M. M. O'Shaughnessy, City Engineer of San Francisco, said: "I understand lately the County Board of Supervisors of Los Angeles, in the plentitude of their political wisdom —after awarding a dam contract—dispensed with the Board of Consulting Engineers who had been employed on the San Gabriel Dam, a work involving an expenditure of $25,000,000. I believe this is a daring act of ignorance on their part, and a consulting board of wisdom and experience should be retained to supervise all features of the construction of this extraordinarily large project. In San Francisco we spent over a quarter of a million dollars hiring the best consultants in the United States to pass on the merits and features of our water project, and I believe it was the wisest money ever spent by the city."

If one board of three consultants was none too many on the San Gabriel Dam project, a dozen such boards would be no more than adequate for the Colorado River project and the other projects that may serve to postpone going to Colorado River. When we suggest several independent boards we have in mind the desirability of avoiding falling into ruts. Where a large number of men work on a board, usually a "we too" tendency develops, whereas what is really needed is more individualism. Moreover, competition among engineers, as among any other class of men, is the best of spurs.

The Rock-Fill Dam as a Safe Structure Where Bed Rock Is Faulted

After spending $3,000,000 in preliminary work and excavation, the proposed $25,000,000 dam in San Gabriel Canyon, near Los Angeles, will probably be abandoned. The faulted condition of the bed rock has become more evidently serious at greater depths.

The failure of the St. Francis dam, probably as a result of movement of the earth's crust along a fault beneath the dam, is still vivid in the memory of Californians. Hence the recent large slide of rock during the excavation of the San Gabriel dam foundation may spell abandonment of that dam site. Yet we raise the question whether this very favorable site should be abandoned. While we doubt the wisdom of building a concrete dam at that site, we believe that a great rock-fill dam could be safely built there.

As many of our readers know, the rock-fill type of dam consists of uncemented rocks sheeted on the upstream face with an impervious sheet of wood or metal. It resembles an earth dam in its massiveness, but differs in being permeable to any water that leaks through the sheeting. Consisting mainly of large stones, leakage streams do not cut the dam away as would occur if it were made of earth. Indeed, its very porosity is a safeguard, for no water can accumulate in its interior.

In a site where faulted rock exists, the rock-fill dam is unquestionably the safest type, if there is any likelihood that a slip may occur along the fault line. In a district subject to slight crustal movements, no fault should be regarded as a "dead fault." Geology is not yet such an exact science that a distinction can be drawn between "live faults" and "dead faults," other than one as to frequency of movement. Given a sufficient period of time, and it is probable that every "dead fault" will come to "life" again, just as many an "extinct" volcano has suddenly ceased being extinct.

The editor has found that there are 12 molton whirl centers in the earth, and that they are still active. Since these molten whirls are caused by the same electromagnetic forces that cause cyclonic storms, earthquakes are most frequent when great storms are most frequent. There is one great sunspot, storm and earthquake cycle about 81 years between "peaks," the last peak being about 1870. There is another similar cycle of about 161 years, its last peak being in 1778. There is another cycle of about 322 years, its last peak being in 1675. Halfway between these peaks, and often at intervals of one-sixth the length of these cycles, great weather and crustal disturbances occur. And the same holds true of the 11.2-year cycle, whose last peak was about a year ago, and whose weather and earthquake effects have been so pronounced at intervals during the past 18 months.

About 1939 and 1951 great crustal disturbances will occur, for those are the peak years of the 81 and the 161-year cycles. A fault that has been "dead" since 1871 may suddenly become alive in 1939 or sooner. So the geologist who bases his decision as to "deadness" of a fault upon evidence less than half a century old risks not only his reputation but the lives of all who live within the flood flow from a bursted masonry dam built over a "dead fault."

The only types of dam that have yet been built that invariably have resisted such crustal movements are those of earth or of loose rock. We have yet to hear of a dam of those types that has been destroyed by a crustal slip. Whereas, for reasons given at length in our issue of May, 1928, the St. Francis dam undoubtedly was destroyed by a slight movement of the rock beneath it along the line of an old fault. Other mysterious failures of masonry dams may have had similar causes.

California is the original home of the rock-fill dam, we believe. At any rate, there are many such dams in that state, and few in other states. Originally designed as an economic way of impounding water for placer mining use, it soon came into use for irrigation reservoirs. Later it was used by hydroelectric power companies, notably the Southern Sierras Power Co. and the Nevada-California Power Co., whose dams were studied by the editor a few years ago during an appraisal that he was making of the properties.

To the engineers of California we recommend a careful study of all the rock-fill dams in that state, with a view to using that type of dam wherever an otherwise good dam site is marred by faults in the bed rock.

Announcement of Articles on the Electron Theory of Weather and Allied Phenomena

In October a series of articles on the electron-whirl theory started with one on "Five Important Weather and Earthquake Cycles" in Water Works and Sewerage, and one on "The Periodicity of Geological Epochs" in Engineering and Contracting. This series will contain 16 or more articles based on the same theory, the articles relating to rainfall and air currents appearing in Water Works and Sewerage, while those relating to the geological and astronomical phases of the electron-whirl theory will appear in Engineering and Contracting.

The researches on which these articles are based have taken nearly all of the writer's time during the past three years. Starting as an inquiry into the relationship between sunspots and weather, the study broadened when it was found that in the neighborhood of certain centers of permanent cyclonic air whirls there is clear evidence of permanent whirls of the molten matter beneath the earth's crust. Later it became evident that the vagaries of the magnetic needle are largely accounted for by these same molten whirls, even to the slow oscillation of the magnetic poles. Since the molten whirls obviously affected topography, it became necessary to study the location of mountain chains and islands and the shapes of continents, in relation to these whirls; and from this gradually emerged the conception that 12 great molten whirls have been the main architects of the earth's crust. Never was the unity of nature better illustrated than in the correlation of phenomena seemingly so different as are sunspots, earthquakes, storms, and terrestrial lines of magnetic force. Aurora and magnetic storms had been previously correlated with sunspots, and one astronomer, Jerome Ricard, had been using sunspots as a means of predicting rainfall. Huntington had found a relation between barometric pressure and sunspots. Douglass had shown that radial tree growth often discloses an eleven year cycle corresponding to a well known sunspot cycle. De Geer had found the same cycle in the varying thickness of the annual sedimentary laminae ("varves") in ancient glacial lakes. Indeed, no small array of facts relating to the weather periodicity were available; but they were bound together by no definite theory susceptible of proof by an appeal to the laws of probabilities. Astronomers were in doubt as to the cause of sunspots. Meteorologists were in no doubt as to the cause of cyclonic storms, but unfortunately they were wrong, for their theory was in conflict with many facts. Geologists were in disagreement as to the cause of crustal movements and were not disposed to see much significance in facts that pointed toward their periodicity. Physicists had given but little thought to the electron as a cosmic force, and almost no thought to it as a force capable of causing weather changes. In general, astronomers ignored weather, weather men ignored astronomy, and physicists almost ignored both of those fields as realms of electron activity.

Under these conditions, it seemed to the writer that an engineer might be capable of coordinating facts and theories in these three realms of science; for since engineering consists in applying science, an engineer is not only capable of understanding any science, but of drawing sound inferences from scientific data.

Engineering is such a cosmopolitan profession that its followers are engaged in every sort of scientific work, from astronomy to farming, from the most purely "pure" to the most purely practical use of organized knowledge.

We take this occasion again to urge upon engineers the cultivation of a greater confidence in their ability to fathom nature's mysteries, regardless of the artificial realms in which scientists locate them. Nature is not a congeries of entirely independent classes of energy, but is a vast array of phenomena that are closely kin and probably identical as to the ultimate units whose varied motions and groupings produce this infinite variety that we call the universe.

H. P. Gillette

Water Works and Sewerage

H. P. GILLETTE, Editor

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Sewage Disposal at Amarillo, Texas

General Features of New Plant, Including Preliminary Settling Basins, Aerating Tanks and Sludge Lagoons

By WYNKOOP KIERSTED
Consulting Engineer, Kansas City, Mo.

AMARILLO is located on the High Plains in the Panhandle of Texas at an elevation of about 3,600 ft. above Gulf level on a divide between the South Canadian River and the Pala Duro Creek, a branch of the Brazos River. The ground slopes moderately south and southeastward and rather rapidly north and northeastward into the valley of the South Canadian. For a long time the city was a distributing center of a stock raising country under moderate agricultural development. Its public utilities had kept pace with its growth and were ample for its use until the intensive development of the gas and oil field commenced about 60 miles northeast of the city. The vastness of the oil and gas bearing territory and its great possibilities advertised Amarillo extensively and it became a center for oil and land speculation. A large amount of capital went into oil and gas development, new additions were laid out in the city, and the rapid growth of commercial and industrial enterprises resulted in much building activity and a correspondingly great growth of population. Within a period of two years the population of Amarillo nearly trebled and is now estimated at 45,000 to 50,000 inhabitants. The demand for the extension of the public utilities became correspondingly urgent and even the private utility companies had some difficulty in keeping pace with the demand.

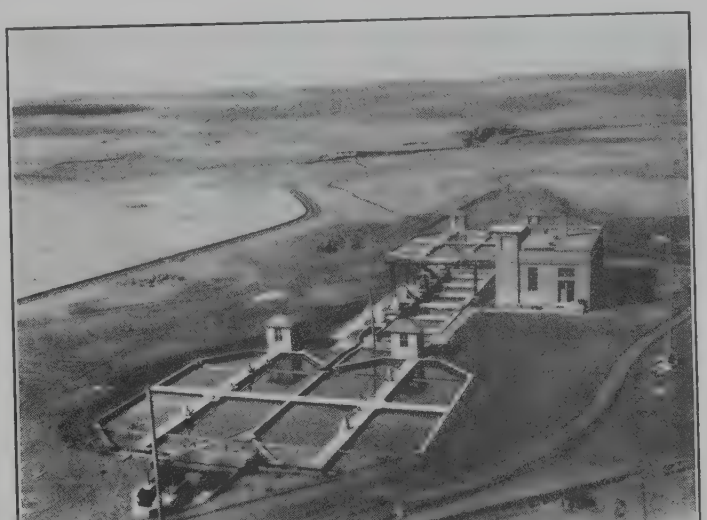

Fig. 1—General View of Settling Basins, Aeration Tank and Blower House

The Old Disposal Plan.—There are no perennial streams in the vicinity of Amarillo, consequently the city had constructed Imhoff tanks for the disposal of its sewage, discharging into one or more irrigating ditches which distributed the sewage over an area of about 120 acres, which was the only portion of the city owned section of land susceptible of irrigation. The land was cropped but the area was too small for successful broad irrigation and considerable offense arose as the result of overtaxed ground. This condition, together with the usual troubles with Imhoff tanks grew steadily worse until the commission, pressed for a remedy for offensive odors, constructed an outfall sewer from the Imhoff tanks 4 miles to a discharge into East Amarillo Creek.

The bed of this creek is dry for the greater portion of each year except for an occasional pool of water sustained by trickling springs and has an average fall of a little over 27 ft. to the mile for approximately 17 miles to its junction with the South Canadian. The constant flow of raw sewage in this ephemeral stream caused nuisances and completely destroyed the value of its water for stock raising purposes, one of the chief industries in that section of the country. With the rapid increase of population these conditions became intolerable and finally the city determined to extend and improve its sewage disposal plant.

Preliminary Investigation and Report.—The author of this paper in making an investigation and report on the situation found that land values were rapidly increasing and that urban growth was continually progressing towards the city owned section of ground on which its disposal plant was located and in fact had passed this section along the adjoining Colorado-to-Gulf Highway. For this and other reasons a new disposal plant was advocated on a site in the valley of East Amarillo Creek four miles below the end of the city outfall sewer. The site selected was particularly advantageous because it is two miles from the nearest residence and the public highway and because here there is a tract of 400 to 600 acres of gently sloping ground in the valley of East Amarillo Creek which could readily be brought under irrigation—a very desirable consideration in an irrigating country.

The author recommended the removal of 80 per cent of suspended matter of the sewage in settling basins and the application of the effluent from the settling basins to land in broad irrigation during the growing season and the chlorination of the effluent from the settling basins and discharge into East Amarillo Creek during the non growing season. The city commissioners demurred on obligating the city to the operation of a large sewage irrigated farm as a municipal enterprise but were willing to turn the sewage over to the owner of the property for use in irrigation as a private enterprise. In the end the commission requested the engineer to prepare plans for a trickling filter to receive the settled sewage

with a provision in the specification to receive bids on the trickling filters independently. The author also recommended sludge disposal in lagoons, both because of the isolation of the site and because the available funds were insufficient for the construction of separate concrete digestion tanks.

The lowest bid on the four miles of 18 in. outfall sewer was $52,489, that on the settling basins and lagoons $121,000 and that on about an acre of trickling filter $124,900. The bids on the filter

Fig. 2—View of Disposal Works and Lagoons

were finally rejected because of insufficient funds, but contracts were awarded for the outfall sewer and settling basins. The former was completed in the early fall and the latter in the late fall of 1928. A general view of the settling basins, aerating tank and power house is shown on Fig. 1. Figure 2 shows a partial view of the structures and the earth lagoons. A space of ground is reserved between the structures and the lagoons for the construction of trickling filters at some future time. In the foreground of Fig. 1 is the two-compartment screen chamber equipped with inclined bar screens, the necessary valves and an overflow well between the two compartments. The screen chamber connects with the preliminary settling basin by concrete conduit.

The Preliminary Settling Basin.—The preliminary settling basin in the foreground is composed of two compartments, each compartment having two cone-shaped hoppers provided with a vertical rotating shaft with two horizontal arms to which is attached a chain drag. The two compartments are, as a rule, operated in parallel but either may be emptied and the sewage diverted into the other by means of stop planks. The sewage enters each compartment on the longitudinal center line and is given a straight line flow through the basin by means of a suspended wooden baffle with vertical slots the entire depth of the baffle ⅝ in. wide and 6 in. apart. These baffles extend nearly to the bottom of the basins. The sewage is removed by a double-lip weir extending across each compartment of the basin in the position shown in Fig. 1. The position of the weir tends to prevent currents up the wall. The two little structures at the end of the settling basin (see Fig. 1) house the motor and reduction gear which communicates with the line shaft running along the center line of each compartment and which rotates the chain drags. The speed of operation of the vertical shaft is 3 revolutions per hour. The object of using chain drags is to prevent adhesion of the settled solids to the concrete bottom of the hoppers. The sludge is drawn hydraulically through a compound plug valve in each of the hoppers. The larger opening of each plug valve is 12 in. diameter and the small one 3 in. diameter. The 3 in. valve is intended to be partially open all of the time or opened periodically. The 12 in. valve is opened only when desired to drain the basin. The detention period in the preliminary basin is 2 hours at an average rate of sewage flow of 3 m.g.d.

The Aerating Tank.—The sewage from the preliminary basin passes through a flume into an aerating tank 95 ft. long, 19¾ ft. wide and 10 and 20 ft. deep and is given straight line flow by means of a suspended baffle extending nearly to the bottom of the tank with ¾ in. vertical openings spaced 6 in. apart. The aerating tank contains six steeply sloped hoppers 10 ft. deep with a plug valve in the bottom of each hopper connecting with a drain constructed beneath the floor lengthwise of the tank. A 12 in. air-lift pump is installed in each of the six hoppers. Each pump has a capacity to lift 1,240 g.p.m. 4 ft. with air of 3 lb. pressure. The pumps discharge the sewage into a concrete trough constructed on the top of the aerating tank and shown on the left side of the tank in Fig. 1. The sewage thus pumped into the tank flows back to the inlet. The six pumps operating continuously deliver sewage into the trough at the rate of a little over 10½ m.g.d. Thus the sewage is withdrawn from the tank, aerated and returned to the inlet and nearly four times during the one hour detention period when the flow from the preliminary basin is at a rate of 3 m.g.d. The purpose of the aeration is to remove the gases from the sewage and to break up insofar as possible the colloidal condition of the suspended sediment. Little oxidation of dissolved organic matter is expected. The sewage is weired into a trough at the outlet end of the tank, thence passing into the secondary settling basin which is structurally a duplicate of the preliminary basin. Thus the sewage is detained in the settling basins and aerating tank 5 hours at the stated normal rate of flow.

The Sludge Lagoons.—The sludge lagoons, covering an area of between 3 and 4 acres, were constructed of earth embankments in three divisions of approximately equal capacity of an average depth of about 11 ft. It was designed to use one at a time until fully charged with sludge, then deliver the sludge to the second lagoon while that in the first was digesting and so on until the use of the third became necessary when the sludge in the first should be in a condition for removal. The overflow from the lagoons passes onto a 5-acre leveled area inclosed by a low embankment where it is expected to disappear by evaporation and by seepage through the ground into the adjoining stream. Since the evaporation in the Panhandle district of Texas approximates 5 ft. per year, no difficulty is expected in disposing of this overflow by evaporation. Some odor is expected from the lagoons, but because of their isolation and the prevailing southerly winds no offense is expected to dwellers along the highway two miles to the westward.

The Blower Units.—The building adjacent to the aerating tank contains three Connersville blowers, each unit having a capacity to compress 700 cu. ft. of free air per minute to a pressure of 3 pounds and to deliver it to the air-lift pumps. These motor driven blowers of the rotary displacement type operate at 575 r.p.m. The air for the blowers enters the tower at one corner of the building, passes downward through air filters, thence into a duct beneath the floor of the blower room to the blowers and is delivered to the pumps through a 12 in. pipe line. In the building are also installed a Wallace & Tiernan chlorinator and a dry feed machine for feeding either alum or copperas either where the sewage passes into the aerat-

ing tank or into the secondary settling basin.

The plant has now been in operation about a year. An average of two weeks', analyses of the sewage passing through the outfall sewer prior to the construction of the new sewage disposal works, showed the dissolved and suspended solids to be 1,570 p.p.m., dissolved solids 1,120 p.p.m., suspended solids 450 p.p.m., hydrogen-ion concentration 6.8. The total dissolved solids in the city water supply was 363 p.p.m. This unusually strong sewage for a city like Amarillo is due in part at least to the absence of ground water infiltration and to the scarcity of city public water supply at the time the tests were made. Provision was made for prechlorination of the sewage at the head of the outfall sewer near the city limits in order to delay septic action at any time the sewage was found to be septic as it entered the disposal works. So far as we know there has been no occasion to prechlorinate because the time of passage through the 8 miles of outfall sewer, half of which is laid at an average gradient of .66 per cent and the other half at an average gradient of .25 per cent, has not been long enough to start any pronounced septic action.

Operating Results.—During the time the disposal plant was under construction about a mile of irrigation ditch was constructed; the owner of the adjacent property, extending for miles in every direction, having arranged to irrigate some at least of his land susceptible of irrigation. After the disposal plant had been in operation several weeks an efficiency test was made of it in December, 1928. For the first five days of this test the sewage passed through the old Imhoff tanks near the city limits. It entered these tanks with 520 p.p.m. of suspended matter but the effluent still contained 205 p.p.m. This effluent then was passed through the new disposal works where the suspended matter was reduced from 205 p.p.m. to 45.5 p.p.m., which represents nearly 78 per cent removal of the suspended solids in the Imhoff tank effluent. The Imhoff tanks were then cut out and the raw sewage, still containing 520 p.p.m., was passed directly through the new disposal plant in which the suspended solids were reduced to 30 p.p.m., representing an average removal during the five days' time of the test of 94.2 per cent of suspended solids. The average condition of the effluent from the preliminary basin during the test was 60 p.p.m. of suspended matter, or about 88.46 per cent removal. The remaining 30 p.p.m. removed in the secondary settling basin after aeration is equal to 50 per cent of removal of the remnant from the preliminary basin or little over 5.7 per cent of the total suspended solids. No records of summer time operation are now available. The records further show an average removal of suspended matter up to Feb. 5, 1929, of a little over 89 per cent and a reduction of the biological oxygen demand of 63.7 per cent on the basis of the 5-day test.

The plant is capable of removing at least 90 per cent of the suspended matter under careful supervision. We are informed that the city commission entered into contract with the owner of the property adjoining and including East Amarillo Creek to remove 90 per cent of the suspended matter in the sewage delivered to the disposal works. With this 90 per cent removal the sewage is in excellent condition to be applied to land in broad irrigation without becoming offensive and in the same condition it is thought it could be applied to a trickling filter with 6 ft. depth of stone of about half the area generally allowed for the purification of the effluent from Imhoff tanks. This distinctly represents a probable economy of the usual plant investment since a filter is more expensive than a settling basin.

Contract for Well Drilling

Well drilling involves many uncertainties, and even without a guaranty as to water the driller assumes much financial hazard. A form of contract that gives a driller an adequate reward for skillful performance without requiring him to assume undue hazards is given by Oscar E. Meinzer in U. S. Geological Survey Water Supply Paper 597-C, "Problems of the Soft-Water Supply of the Dakota Sandstone." We quote as follows:

If the water is obtained from hard rocks, the driller may have performed his entire duty when he has sunk the hole to the required depth. If, however, the water occurs in beds of sand or other incoherent material the driller's work is not complete when he has made the hole, but only when he has, so far as possible, developed or finished the well in such a manner that it will yield a water supply without inflow of sand, silt, or clay and will remain in good condition for a period of years. The process of developing or finishing the well requires quite as much skill as the process of making the hole, and, if properly done, it may consume much time. A reliable driller will not leave a well in an unfinished condition or in a condition that will cause trouble in the future. However, if he is paid only at a certain rate per foot for making the hole, he can hardly afford to spend much time in developing the well, and if he does so he is at a great disadvantage with his less scrupulous competitors. In localities where wells end in sand it is therefore desirable to devise a form of contract that will give the driller adequate reward for skillful work in finishing a well without requiring him to assume undue hazards. Such a form of contract will also be advantageous to the persons for whom the wells are drilled, for it will tend to give them the services of skillful drillers on competitive terms.

The problem of a proper form of contract confronted the United States Office of Indian Affairs when it asked for bids for drilling the well at the asylum at Canton. The following specifications are essentially as they were prepared by the Geological Survey with a view to meeting the conditions outlined above:

Specifications for one well to be sunk at the Asylum for Insane Indians, Canton, S. D., into the sandrock that bears soft water:

The bidder shall furnish all equipment and labor necessary properly to construct and finish the well and shall furnish the casing and strainer and any other material or element that may be required to construct the well in a workmanlike manner. He shall case the well from top to bottom with 8-in. standard casting or pipe. [Diameter was later specified to be 6 in.] He shall so construct the well at the bottom as to shut off and seal the well from any water entering from above the soft-water sandrock. He shall also construct the well in the soft-water sandrock at the bottom in such a manner that it will furnish at least 15,000 gal. of water in 24 hours without interference or trouble from sand or any other cause during a pumping test of at least two days' duration. He shall commence sinking the well within a reasonable period after the approval of his contract, shall continue operations without any unnecessary delay until the well is finished, and shall complete the well by Nov. 1, 1926. When the well is completed with the above-mentioned guaranty as to yield and freedom from interference by sand or from other trouble, he shall receive full payment at the rate of $—— per foot of well drilled.

It is understood that the well shall be drilled to a maximum depth of 350 ft., if necessary, unless the hard Sioux quartzite, or "Sioux Falls granite," is struck before that depth is reached. It is further understood that in case it is impossible, on account of the absence or unsatisfactory character of the sandrock, to fulfill the above-mentioned guaranty, the contractor shall be paid at the rate of one-half of the above-mentioned price per foot drilled.

Because of the guaranty of "15,000 gal. in 24 hours without interference or trouble from sand or any other cause during a pumping test of at least two days' duration," the contract was attractive only to skillful drillers, and it gave the successful bidder a strong inducement and a proper reward for doing his best work. On the other hand, by specifying half price if the driller should not succeed in fulfilling the guaranty, he was protected from assuming an excessive hazard. In general, government contracts for drilling wells have been very exacting in their requirements, and this has resulted in discouraging bidders and in making the bids excessively high. It is believed that an equitable and reasonable contract is to the interest of the government in procuring the services of skillful and reliable drillers at moderate prices.

The advantages of this form of contract could, of course, have been obtained with specifications of other kinds. For example, the driller might be paid a certain price per foot for making the hole and an additional sum for fulfilling the guaranty. This would not be very different in effect from the actual specifications but would have the disadvantage of requiring a more complicated bid and of being a more radical departure in form from the usual contracts.

The successful bidder for the contract for the asylum well was Mr. E. C. Archibald, Council Bluffs, Ia., whose bid of $5 a foot was the lowest submitted.

Developments in 1929 in the Chemical Treatment and Filtration of Water

Taste Elimination—Prevention of Corrosion—Water Softening—New Filtration Plants—Coagulation —Laboratory Work—Bacterial Quality—Design and Equipment—Filter Clogging —The Surface Wash—Aeration and Chlorination

By JOHN R. BAYLIS
Associate Editor, Water Works and Sewerage

THE articles on water purification which have appeared in the various publications within the past 12 months indicate we are moving forward in this field at a very rapid rate. They cover practically every phase of water treatment, and it is evident that our scientists in the water purification field are keeping pace with those in other lines of work. Certainly there is no period in history in which the work has been on so high a plane or the achievements greater. The American Water Works Association with its water purification division and 17 local sections, the New England Water Works Association, the American Chemical Society, the American Society of Civil Engineers, the various state organizations which hold annual meetings, such as water works schools and conferences, and other technical societies, all have programs at their various meetings with one to a number of papers on water treatment and filtration. In addition to the proceedings and journals of these organizations, there are several other publications giving a great deal of space to water purification. Surely such an abundance of literature records much that represents improvement in the treatment of our drinking water. Also it is creating an interest in the subject far greater than our expectation of only a decade ago.

It is not one or two achievements that makes the past year noteworthy in accomplishments, but improvements along many lines. The young and the old, the newcomer and the veteran in water purification have put their shoulders to the wheel and we are moving forward in a manner that makes us feel proud. The most difficult problems are being attacked by men well trained in their work, and some of the problems that have baffled us heretofore are being solved. Each year brings about a greater sense of responsibility on the part of the chemist and the engineer to produce safer and more palatable water.

Water Borne Diseases Have Been Reduced to a Minimum.—The death rate of water borne diseases is diminishing almost to the vanishing point. Seventy-four cities with a population of 26,737,000 people reported 1,796 deaths from typhoid fever in 1918. These same cities with a population of 33,116,000 in 1928, reported only 627 deaths from the same cause. This is a reduction from 6.72 per 100,000 in 1918 to 1.89 in 1928, or over 70 per cent. We should like to think that only a few of the cases of typhoid fever in 1918 were contracted from water, for most of the plants had very good treatment for the removal of bacteria at that time. The record indicates, however, that there has been no let-up in the efforts to have the water entirely free from disease producing bacteria, even though some of the supplies before treatment have become more highly polluted. Before a supply becomes contaminated to the point where there is doubt as to the safety of the water, and a less polluted supply is not available at a reasonable cost, improvements are made in the methods of treatment so as to take care of the increased pollution.

Taste Elimination.—More and more do we realize that the public wants water of the highest quality and water free from objectionable tastes. Perhaps the greatest achievement in the water purification field for some time has been the perfection of treatments to remove or to prevent objectionable tastes. This, of course, is not a development originating within the past 12 months, but much has been contributed to our knowledge of taste elimination during that time. Many water supplies at times are subject to disagreeable tastes that cannot be removed by coagulation and filtration. In some instances filtration has been discredited in the eyes of the public because perfectly palatable water is not being supplied all the time.

Efforts in taste elimination have been along several lines. Probably the most notable contribution to taste elimination within the past few years has been made by Howard at Toronto. An excess of chlorine is added, and the water is later dechlorinated with sulfur dioxide. McAmis at Greeneville, Tenn., was the first to use ammonia in this country on a plant scale for taste elimination. Spalding at Springfield, Ill., and Ellms at Cleveland, O., report good results with ammonia. Potassium permanganate is being added to several water supplies with apparently very good results. Caird at Rochester, N. Y., was the first to use this material on a plant scale. Harrison at Bay City, Mich., finds potassium permanganate effective in preventing tastes, but does not get very good results with ammonia. Recently it has been found that activated carbon is very effective in removing taste-producing compounds from water.

Ammonia apparently prevents the formation of the chloro compounds that produce disagreeable tastes. Potassium permanganate and superchlorination oxidize certain of the taste-producing compounds, whereas activated carbon absorbs the compounds. With a combination of superchlorination and activated carbon, which also dechlorinates the water, practically all objectionable tastes that are likely to occur in a water supply may be removed. Superchlorination, preammoniation, and the use of potassium permanganate have the advantage that very little plant investment is necessary, but such treatments require close supervision. Reports from various points where these treatments have been tried indicate they are not successful in the complete elimination of all tastes, but certainly they can produce a marked improvement in the taste of the water in many localities.

No one so far has reported a taste that cannot be removed by superchlorination and then passing the water through a bed of active carbon. The use of the active carbon also obviates the necessity for close chlorine control. Such excellent results should insure extensive use of this process. Due to the fact that the carbon is expensive, and that provision has to be made for passing the water through a bed of the material, the initial cost is high. The operating cost is low, and when every thing is taken into consideration the cost compares very favorably with other treatments. The fact that this treatment covers a wider range of taste-producing compounds that may be removed from water than any other treatment, and is almost fool-proof in operation, should make it particularly attractive to small cities.

If progress in water purification had been confined to taste elimination, the past year would still be noteworthy for its accomplishments. It has been demonstrated conclusively that the more common taste-producing compounds, such as are produced by decaying vegetation, micro-organisms and phenols,

may be completely removed by one or more of the several methods mentioned. No city willing to make the small expenditure need now tolerate disagreeable tastes, except perhaps in very unusual cases. It appears that most any water may be made perfectly palatable all the time for an expenditure less than $1.50 per million gallons.

Prevention of Corrosion.—Treatment of water to prevent corrosion and red water is being extended gradually to the corrosive waters. It has been about 10 years since the treatment was started at Baltimore, and every year sees a few more cities added to the list of those treating water to reduce corrosion. If the writer is correctly informed, New York City has abandoned its work on corrosion prevention for the present. This, however, will not discourage others who are anxious to deliver water to the consumer of the highest quality. In fact lime was not tried in New York on a large scale, and those who are familiar with corrosion prevention would not expect the sodium compounds to be of much aid on so soft a water. The advantages and economy of non-corrosive water are demonstrated quite conclusively in practically all places where it is given a fair trial, and it is likely only a matter of time until nearly all corrosive waters will be treated. Where various treatments for corrosion prevention, such as lime, soda ash, sodium hydroxide and sodium silicate, have been compared on a plant scale, lime shows its superiority over other treatments for very soft waters. For moderately hard to hard waters it probably makes little difference which material is used, except that lime is cheaper.

Water Softening.—More water softening plants are being constructed every year, and some of the existing plants are making their treatment processes still more effective. Where magnesia is present in quantities greater than 10 to 15 parts per million of Mg there is an increased use of what is commonly called the excess lime treatment. Lime is added to the water to produce a pH of 10.5 to 10.8 so as to precipitate most of the magnesia as magnesium hydroxide. This treatment leaves the water with 25 to 50 parts per million of caustic alkalinity, composed largely of calcium hydroxide. The caustic alkalinity has to be converted to the carbonate by the addition of carbon dioxide.

The greatest precipitation of calcium carbonate that may be effected within the few hours it takes the water to pass the treatment plant occurs at a pH of 9.5 to 10.0. This is high enough to give the water a taste characteristic of lime softened water. The use of carbon dioxide in softening plants is becoming more extensive, and the writer is of the opinion that practically all municipal softening plants using lime or soda will eventually recarbonate the water. The water should be left just saturated with calcium carbonate, or with only 4 to 5 parts per million supersaturation. In softening processes where calcium carbonate is precipitated, considerable supersaturation of calcium carbonate has to be produced for precipitation to take place. Usually 20 to 40 parts per million supersaturation of this compound is left in the water and it will incrust the sand grains in the filter beds and all surfaces with which the water comes in contact unless the water is given additional treatment. The addition of carbon dioxide is being found to be the most desirable additional treatment.

Zeolite softening is being extended rapidly to industrial plants where it is economy to have very soft water. There are now four or five municipalities using zeolite softeners. For laundries and boiler plants it is becoming the custom to use zeolite softeners where the hardness is in excess of 20 to 30 parts per million.

Taste elimination, prevention of corrosion, and water softening, constitute efforts to take a water of inferior quality after filtration and produce water of the highest quality. Surely our dream of the perfect water for every city is much nearer a realization than was believed to be possible only a few years ago. In many instances the water has been changed so greatly in characteristics due to the treatment that it should be regarded more as a manufactured commodity than one of Nature's products.

New Construction.—Construction of new filtration plants has progressed at about the usual rate. Twenty or more new municipal plants have been put into operation within the past year, the new Howard Bend plant at St. Louis probably being the largest. This plant is probably the most elaborately equipped filtration plant ever constructed. The beautiful exteriors of the new plants at St. Louis and Baltimore, and the interiors of the newer plants at Cleveland, Washington and St. Louis, set a standard in construction that will be followed by many plants in the future. In fact the influence is already noted in the imposing structures recently built in some of the smaller cities. Beautiful structures may not be necessary for the production of high quality water, but they are in keeping with the present tendency to make every thing in connection with water supply attractive.

Coagulation.—There has been only one major development in the coagulation of water within the past two or three years. Mohlman and Palmer found that chlorine added to a solution of ferrous sulfate produces ferric sulfate and ferric chloride, and that these compounds will produce coagulation when the pH is very much lower than is essential for ferrous sulfate to produce coagulation. Their work was on sewage, but it did not take the water chemist long to start experimenting with chlorinated iron to see if it had possibilities in water treatment. Good precipitation has been found to take place between pH of 5.0 and 11.0, making its range very much broader than that of aluminum sulfate. The work of Hedgepeth at Elizabeth City, N. C., Decker and Menke at Chicasaw, Ala., and the writer at Chicago, indicates that chlorinated iron is a better coagulant than aluminum sulfate for many waters. Ferric chloride appears to be even more effective than chlorinated iron, but due to its price being considerably higher than that of ferrous sulfate the cost of coagulating water with this material appears to be higher. It seems probable that the ferric compounds will give aluminum sulfate serious competition and probably will result in lessening the cost of coagulating water. The past year has contributed much to our knowledge of the use of chlorinated ferrous sulfate in water treatment.

Laboratory Work.—The hydrogen-ion test is now fairly well understood by water chemists and many are making use of the test in their treatment process. A knowledge of the hydrogen-ion concentration of the water is almost an essential for the most efficient application of chemicals to water, except where very small quantities of aluminum sulfate are added to hard or moderately hard waters.

The use of instruments to measure the turbidity of filtered water is being extended rapidly. The best operated filtration plants are striving to produce filtered water with turbidity not greater than 0.2. In fact we see several other pieces of new equipment in the leading water laboratories in addition to the sensitive turbidimeter, such as laboratory filters, stirring machines, and other experimental apparatus. More attention is being given to the laboratory in new filtration plant designs than heretofore. The new laboratory in the Howard Bend plant at St. Louis, perhaps the most complete of any filtration plant laboratory in the world, makes us feel that the value of the technical workers in such plants has not been underestimated by the designer.

Bacterial Quality.—The present bacterial standard allows an average of not more than 1 B. coli per 100 cc. of water. The better operated plants have set their aim much higher, and many plants are averaging not more than 1 B. coli per 1,000 cc. Until this latter figure is attained, the filter operator is not justified in reducing the treatment to save operating costs. In fact we may look for 1 B. coli per 1,000 cc. being the standard some day. The chemical advantage of superchlorinating polluted water is becoming so apparent that it will be this and not bacteria that will determine the amount of chlorine to be used in many plants. With a residual chlorine requirement of from 0.3 to 0.5 parts per million two or three hours after application, the

bacterial test becomes almost useless. The quality is insured by the residual chlorine test, and the safety of the water is known immediately and not several days afterward, as is the case when we have to wait for the bacterial results.

Design and Equipment.—In plant design and equipment there have been no recent developments of major importance. Most of the new plants are installing dry feed machines for applying the chemicals to the water, but this is more a matter of choice than any superiority of one method of applying chemicals over another. Better means of handling and storing chemicals are being provided. Air conveyors appear to be on the increase for transporting chemicals in the larger plants. Softening plants and other plants handling highly turbid waters are making greater use of continuous sludge removing devices in the settling basins. The value of a fairly long mixing period has been demonstrated in most waters, and most of the newer plants are being equipped with mixing basins having ample mixing time. Mechanical mixing appears to be on the increase.

There has been no radical change in the design of filter beds. Some of the newer designs have the sand beds located lower so that there will be little or no negative head on the beds. This lessens air-binding troubles. Twenty-four to 27 in. of sand is usually specified, and there is a tendency to use slightly coarser sand than a few years ago. It has been found that sand of 0.5 mm. to 0.6 mm. for the 10 per cent. size usually gives good filtration results and does not clog so quickly as finer sand. There still exists a variety of opinions as to the best type of underdrains for filter bottoms. With all the efforts that have been made to improve the filter bottom it is doubtful if anything so far tried has much superiority over perforated pipe laterals. The manufacturers of filter rate controllers and other devices for filtration plants have not come out with new models so frequently as manufacturers of automobiles and radios, but every year sees something new, or something that has been improved.

Solving Filter Clogging Troubles.—There has been a more determined effort to solve filter clogging troubles than heretofore. Hulbert and Herring at Detroit believe that a high rate of wash to give a sand expansion of nearly 50 per cent during washing will keep the beds in good condition. It is their opinion that an expansion of 40 to 45 per cent is the minimum for satisfactory results. It is hoped that so simple a treatment will produce the desired results, but the writer is of the opinion that it will not for many waters. It is true that many filter operators give very little attention to the wash rate actually being used, and it may be found that many plants are not using the 24-in. vertical rise for which the plant was designed, if a check-up were made. If sand expansion can be measured conveniently enough to insure its regular use, it will result in improved conditions at many plants. Is it not imposing a task on the operator that he very likely will not perform with a degree of regularity sufficient for good results? The writer is of the opinion that mechanical rakes or the surface wash is the only real solution to much of our filter clogging trouble. Mechanical rakes are not practical except in small circular filters, but the surface wash may be used on any size and shape bed.

The Surface Wash.—The surface wash is composed of pipe laterals located just above the sand surface and spaced about 18 to 24 in. apart with holes about 3/16 in. in diameter about 12 in. apart on both sides of the laterals. The holes are pointed downward at an angle of about 30 deg. to the horizontal. With a pressure of 20 to 30 lb. on the jets considerable agitation of the sand in the path of the jets is produced. The surface wash is used at the time the filter is washed from underneath. The force of the jets extends some distance from the pipes, but it is not great enough to disturb the gravel. Neither does it disturb the water above the suspended sand any more than it is disturbed by the usual wash. The force of the jets greatly agitates the sand and break up all mud balls and clogged masses of sand. The application of wash water underneath the bed to produce 18 to 20 in. vertical rise per minute and 4 to 6 in. through the surface wash gives an agitation of the sand much greater than can be produced by applying water underneath, regardless of how great the rise per minute may be. The success of the surface wash where it has been tried should insure its use in many filtration plants in the future.

Aeration.—A few of the recent filter plant installations provide for aeration. This is helpful in removing dissolved gases such as carbon dioxide, and in reducing certain of the taste and odor producing compounds. Aeration also is used for increasing the dissolved oxygen content of water low in dissolved oxygen. Recent developments in taste and odor removal indicate that aeration will not be extended very much for this purpose.

Chlorination.—Chlorine is being used in such a variety of ways in water treatment that no one can predict what the future will bring forth. The chief recent developments involving the use of chlorine other than for sterilization have been mentioned already. The addition of chlorine to the water in advance of filtration is on the increase, and the writer is of the opinion that prechlorination is an advantage for many waters.

It seems that one of the most important developments in water purification within the past 10 to 15 years is the type of men being attracted to this field. Ambitious, and well trained in the fundamentals of water treatment, we may expect much from such workers in the future.

Airplane Surveys Give Base for Plane-Table Work

In contributing to a discussion of the American Society of Civil Engineers on the application of airplane surveys to topographic mapping, W. N. Brown gave the following outline indicating the process followed:

"First, a controlled mosaic is made on plane-table sheets 24x30 in. in size. In order to get an accurate control mosaic, there must be located over the area a number of points that show on the photograph. Coordinate positions of these points must be computed and the points platted on the plane-table sheets. The photographs are then brought to proper scale in agreement with these platted points, and made into a photographic base map, upon which the coordinate lines are drawn. The plane-table sheet is then ready for the field where the contours are located by stadia vertical angle methods.

"The topographer, starting from a known control point, carries a continuous traverse for position and elevation, at the same time checking the accuracy of his photographic base map. This map also serves as a check against mis-read or mis-platted rods. If he reads a rod at a stream fork or fence line, or other definite feature, and it does not agree in position with that shown on the base map, he checks his reading and either discovers it to be his error or picks up an error in his base map. If the photographic base map has been properly controlled and made, the error will usually prove to be his own.

"The economy of field operation is apparent. He does not have to read rod for such details as stream and road location, buildings or other objects, but only takes rod readings necessary for controlling the contour location and checking the base map where he thinks it advisable. The field work is reduced at least 50 per cent. The resulting map has better expression of contours and details of stream than could be obtained for the same money by any other method.

"The error of scaling the distance between any two points located at widely separated distances on the map should not exceed 1 part in 5,000."

Water Purification in North Carolina.—One hundred per cent of the filtered surface supplies of North Carolina are chlorinated. Seventy-four of the 78 filtered supplies are scientifically operated, being either under chemical or chemical and bacteriological control.

Records and Tests for Sewage Treatment Plants

Methods for Determining Efficiency of Grit Chamber and of Solids Removal; Condition of Sludge, and Daily Flow of Sewage

By HERBERT BOSCH

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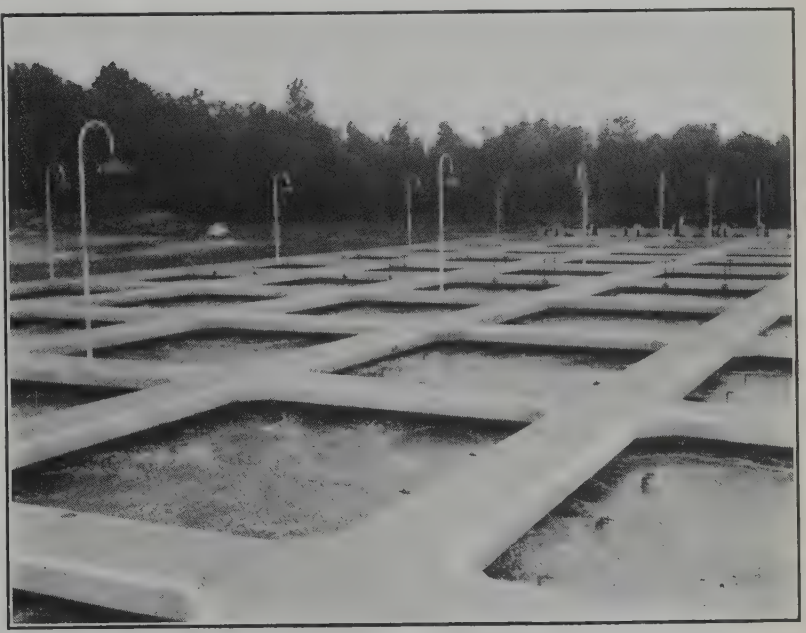
SEWAGE treatment plants are notably very far behind their companion municipal plants, the water works, in the matter of keeping of records and making of tests. The great improvement in the water works field, however, has not come about all at once but has rather been the result of years of constant work. It is not expected that sewage plants will change immediately from their present slipshod operation to a system of efficient control, but there should be at least a gradual trend in that direction. Much depends on the operator. Operation of a sewage treatment plant is a part of the municipal obligation, and the city must employ an operator who is capable of giving the plant intelligent operation.

Why Tests Should Be Made.—There are several reasons why simple tests should be made and records kept at sewage disposal plants. Needless to say, tests will give the operator an index of how efficiently his plant is operating. Despite a rather common opinion to the contrary, there is no type of sewage plant which will keep itself running effectively without attention. Routine tests give an advance warning of conditions which might impair the efficiency of a plant as well as evidence that the plant is running smoothly. Records of efficient operation are of value in court in event of suits against the city by landowners downstream from the plant for damages alleged to have been done by sewage in the stream. It is hardly necessary to point out that such suits are likely to occur at any time.

A second reason for making of tests and keeping of records lies in the fact that almost every town now having a sewage plant will sooner or later have to either extend or rebuild its present treatment plant. At such a time records of plant performance, and of the characteristics of the local sewage will be of inestimable value in making the addition to the old plant or in designing a new plant. There are very little data available now on the properties of sewage in this state and on the operating characteristics of various types of plants, and a designing engineer must depend on data from other localities where the conditions are not the same as they are in this state.

The first simple test which should be made is the temperature of the raw sewage, of the sludge and of the air. Temperature has a great influence on the digestion period necessary. Imhoff states that it takes twice as long to digest sludge at 50° F. as it does at 60° F.

Determining Efficiency of Grit Chamber.—Most plants, especially those which have combined sewers, are equipped with grit chambers, which should be designed to separate the inorganic solids from the influent sewage, but should not trap organic matter. To determine the efficiency of the grit chamber a sample of the grit is dried and weighed and then the volatile organic matter is burned off. The loss in weight represents the volatile organic matter. If it is high, say over 50 per cent, the grit chamber is removing too much organic matter, which tends to become septic and produce objectionable odors.



Aeration Tanks at Sugar Creek Sewage Disposal Plant, Charlotte, N. C.

How to Determine Efficiency of Solid Removal.—Most of the sewage treatment plants in this state utilize Imhoff tanks, but there are also a few separate sludge digestion plants in operation. In either one of these types of plants, some knowledge should be had of how efficiently the settling tanks are removing solids from the sewage. The simplest method of doing this is by means of Imhoff cones. These are glass cones about 15 in. high which are calibrated to hold one liter and are graduated at the tip. A liter of sample is placed in the cone and allowed to settle for two hours. At that time the solids which have settled in the tip of the cone are read off, the results being expressed in cubic centimeters per liter. If this test is made on the raw and settled sewage, the percentage of solids removed is very readily calculated. The only precaution necessary in making this test is to tap the cones gently after about 15 minutes of settling in order to insure that the solids do not adhere to the sides.

In activated sludge plants where sludge is being constantly returned to the primary settling tank, settleable solids are best determined by means of a cylinder rather than a cone. The contents of the cylinder are allowed to stand for one hour, after which it is read, the results again being expressed in cubic centimeters per liter.

If an analytical balance is available, the suspended matter by weight should be determined by the Gooch Crucible method. A Gooch crucible is a crucible provided with a perforated bottom which is covered with a thin asbestos mat. By the aid of suction, a definite volume of sewage is filtered through the crucible after which the crucible is

dried and the increase in weight is noted. From this the suspended matter in parts per million is easily calculated. The per cent removal of solids in the settling tank may be computed if this test is made on the sewage influent and effluent to the tank.

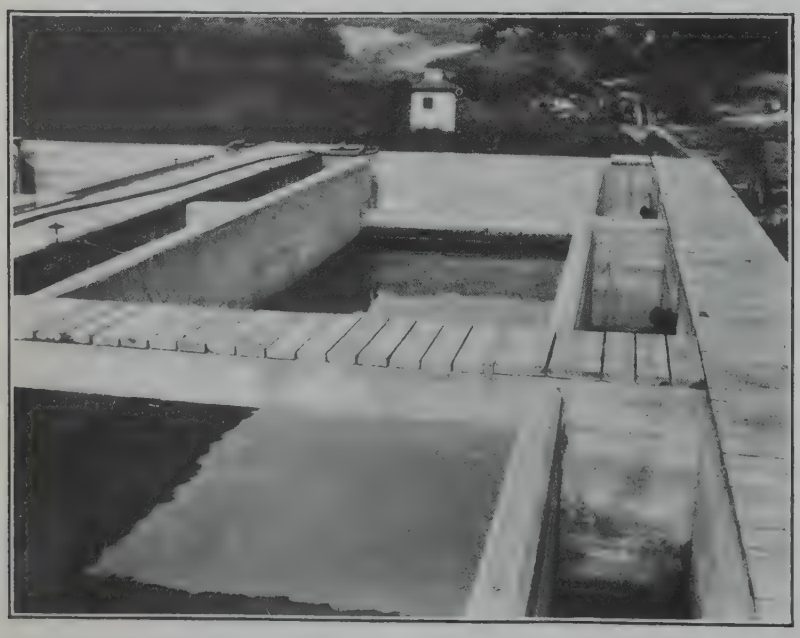
Data on sludge withdrawals should be kept. The data should include the date of withdrawal; the amount of sludge drawn; the quantity of dry sludge which is yielded and the quality of the sludge, and the moisture content of the sludge. The latter is determined by weighing a quantity of the wet sludge and then drying it. The loss of weight represents the moisture content.

Testing Condition of Sludge.—The digestion of sludge is affected by its alkalinity or acidity during digestion. Sludge digestion should take place in an alkaline condition. Some knowledge of the condition of the sludge can be secured by testing it with litmus paper, litmus being blue in an alkaline medium and red in an acidic medium. However a much better knowledge is secured by means of Hydrogen Ion Determinations. The results of this test are expressed as pH numbers. Neutrality is indicated by a pH of 7.0, anything less than a pH of 7.0 is acid and anything greater than 7.0 is alkaline. Sludge digestion is most favorable with a pH of from 7.2 to 7.4 and if the pH falls below 7.0, foaming is apt to occur. Hydrogen ion determinations are made coloremetrically. Dyes are used as indicators and comparison is made with standards of a definite pH. Complete outfits are available which make this determination very simple.

Test of Efficiency of Treatment Plant.—Probably the most reliable test of a treatment plant's efficiency is the test for the biochemical oxygen demand of the sewage. This determination measures the oxygen required to stabilize a sewage. Unfortunately, this determination is rather difficult to make, but an intelligent operator can learn the technique. If it can be made on the raw sewage and on the effluent from the plant, the decrease in the B.O.D. can be easily computed, and from this a knowledge of the efficiency of the plant and the suitability of the sewage for discharge into a watercourse is obtained.

A simpler test for judging the quality of the effluent from a plant which has complete treatment is the methylene blue stability test. This test is made by adding methylene blue indicator to a bottle containing the effluent from the plant and noting the number of days necessary for the solution to decolorize when the temperature is maintained at 70° F. or 20° C. The following table gives the relative stability in terms of the days necessary for the solution to decolorize.

Time required to decolorization at 20° C. (Days)	Relative Stability (Per Cent)
0.5	11
1.0	21
1.5	30
2.0	37
2.5	44
3.0	50
4.0	60
5.0	68
6.0	75
7.0	80
8.0	84
9.0	87
10.0	90
11.0	92
12.0	94
13.0	95
14.0	96
16.0	97
18.0	98
20.0	99



View of Portion of Sewage Disposal Plant of Teaneck, N. J.

It has been found that this test is of little value in judging the quality of the effluent from an Imhoff tank unless secondary treatment is employed. Precaution should be observed not to add an excess of the methylene blue indicator since an excess of the indicator prevents the decolorization of the solution in the time at which it would normally occur and this gives fictitious results.

Determining Daily Flow of Sewage.—Another record which should be kept at the plant is the daily flow of sewage. It is hardly practical to install Venturi meters at the smaller plants for measuring the flow. However, an approximation can be obtained by several methods. One of these is by means of a stroke counter attached to the dosing chamber. From the capacity of the dosing chamber and the number of discharges, an approximation of the sewage flow can be obtained. Another way of roughly approximating sewage flow is by measuring the depth of sewage in a sewer and computing the flow from this and the size and grade of the pipe.

Of course, a convenient record of the test should be made. The value of the tests is increased greatly if permanent records, always available for reference, are kept. Standard forms for keeping of records will be furnished by the State Board of Health.

No attempt has been made to describe the determinations for the ammonias, nitrates, nitrites, chlorides and fats. These tests are of course of value but require a trained chemist to make them. It is believed that the tests outlined above are of greater value as routine determinations for the plant operator. The State Board of Health will be glad to render all possible aid, in the way of instructing operators in the making of tests, to plants which buy the necessary equipment.

Acknowledgment.—The foregoing is a paper presented at the 5th annual meeting of Missouri Water and Sewage Conference held at Chillicothe, Mo., Oct. 21-23.

New York City to Have Municipal Sanitation Commission.—The voters of New York City at the election last month approved a proposition for the establishment of a municipal sanitation commission. The plan provides for the consolidation of several existing city agencies under one head with broad powers over sewage disposal, garbage disposal by incinerators, and elimination of beach pollution. The mayor has power to appoint and remove members of the commission, which will absorb the street cleaning department. The chairman of the commission is to receive $25,000 a year.

The Good Will of the Consumer

Superintendents' Round Table Discussion at Toronto Convention of American Water Works Association

THE best way to handle your consumer is to have a good looking girl at your inquiry window. You cannot beat that combination if she has a nice face and a soft, pleasing voice, because the customers will go away smiling after they have made their complaint. I would rather have a woman handle my consumers than a man. Of course, I always have a man handy so that when it comes down to an argument he is there to explain things, but when you are taking the consumer's money I think a pretty and sweet girl is a combination that cannot be beat.—W. S. Patton, Ashland, Ky.

We have a lady cashier and a man cashier, and they work side by side. The man takes care of the lady customers and their complaints, and the lady takes care of the gentlemen customers and their complaints.—W. S. Cramer, vice-president and manager, Lexington Water Co., Lexington, Ky.

I have found that when you have a dissatisfied customer, in 99 per cent of the cases the best thing is to let him have his say. There is an old saying that if you give a calf plenty of rope he will hang himself. That will pretty well work out in the case of a dissatisfied customer. If you can get him to talk and talk and after he is run down, open up your battery, you will find that the problem is 75 per cent decided. Of course, sometimes the women folks never do run down, but I agree with Mr. Cramer that it is a good thing to have a gentleman look after the complaints of the ladies. I think it is a great mistake to try to argue with a dissatisfied customer.—James E. Gibson, manager and engineer, Water Department, Charleston, S. C.

We send our bills out quarterly, and we read the meter monthly. The object of the monthly reading of the meter is to see that the meter is registering properly, and if we have a very high reading we will notify the customer or leave a card asking them to examine the meter and see if the reading has been correctly taken. Sometimes we send a man to examine the premises, because in that way you will frequently discover a leak. It makes the customer feel satisfied when he discovers that you are taking an interest in his supply. —S. H. Taylor, superintendent, Water Works, New Bedford, Mass.

Some years ago our office staff consisted entirely of men. When a customer came in and saw all men there he would become angry in making his complaint. We decided to employ ladies to collect the bills just for that reason, and we found that it made quite a change. It is a difficult problem to solve when your customer has a bill for $10 and the next one is for $90 and I think it is better to adjust that bill. That customer will never be satisfied if you make him pay that bill, even if you are sure that the water has been used. Do not make the mistake of settling these big bills yourself, or you will have a lot of trouble. The best way is to refer them to somebody else and let them do the settling. We had one customer who came to us frequently with complaints. He had tenants and he never looked after them. We have a practice that when we have a large bill like that in a complaint we issue what we call a customer's complaint, irrespective of whether any complaint has been made or not, and we try to find the reason for the big bill. Usually the girl in the office can make any adjustments when a complaint is made. The heads of departments have no right to give any favors to one customer or another. If one taxpayer uses water carelessly there is no reason why all the rest of the taxpayers should stand the brunt of his carelessness or dishonesty.

It is very poor policy to make adjustments, particularly in a municipal plant. I take the position that in the municipal plant your duty is to serve the public. If you show consideration for one man you should do the same to all. In a private plant if you show consideration to one man, you are simply giving the money of your stockholders away. In a municipal plant you are giving away the municipal funds. At Charleston, a number of times the question has been raised of rebating a high bill as much as 50 per cent. In every case our attorneys have advised us that that is discrimination and cannot legally be carried out. We have three commissioners on the Commission who have paid $90 water bills. When they come to me and ask for an adjustment I tell them that one of the Commissioners has had to pay a $90 bill and that I have no authority to make an adjustment. If they would like to bring the matter before the Commission I would be glad to have that done. Of course, when the matter is brought before the Commission the consumer receives every courtesy and consideration, but the complaint is disposed of in the usual manner, which means that the consumer pays the bill. In one or two instances of these high water bills the consumer does not pay it all at once, but he pays it in small amounts, $1 a quarter, and if he keeps on paying he will get it settled in about 12 years. It usually works out that after he has paid two or three months he gets tired doing that and he wipes out the bill.—J. E. Gibson.

The original question was that of courtesy and good will. I think we all realize that large bills are the paramount factor in dissatisfaction. Originally we used to read the meters and collect monthly all our water bills. Before I went to Omaha they changed over and read the domestic meters every three months. As a consequence, where a leak occurred that was inaudible and invisible, they would make a two-thirds reduction on the bill. Later on we changed that to a two-thirds reduction, assuming that the leak had been found the first month. It makes no difference whether the consumer is a poor laborer or a millionaire, we make the same reduction. In addition to that, whenever a meter seems to be running a little sloppy, and what we think is beyond normal, we notify the tenant that the bill is abnormally high and suggest to him that he look for a leak. We send our inspectors out to find out if there is a leak. I think the biggest factor in regard to courtesy and goodwill is to have a perfectly fair and open discussion with the party who comes in making the complaint and explain to the very best of your knowledge and with patience all the facts in connection with the matter. Try to show him why his bill is high. I think an explanation goes a far way with a reasonable man. Another strong factor is to have employees who have a pleasant manner and a nice method of explaining things.—Theodore A. Leisen, General Manager, Metropolitan Utilities District, Omaha, Neb.

We find one of the best methods of explaining to a customer the reason for a high bill is to check his meter, and follow that up by sending an experienced man to look it over. He takes the customer to the meter and shows the water being registered on the test dial. To show you how it works, we had one of our railway companies that had a 2-in. hose that was left lying on their platform. Several million gallons were wasted in 30 days. The management were not aware that that leak existed. We investigated the matter and found the leak. We found that the man who looked after the water supply had repaired the leak, but we sent the bill into the railway company. Word came back that the bill was out of all possible bounds, and then we gave them the time and date when the leak had occurred and that settled the matter. We have had similar cases in domestic services. Flush tanks in houses are a common source of trouble

because a leak of that kind is something that the householder cannot see, but our expert can take the customer to that tank and show him where the leak is, and show him how it is registering on the meter.—A Member.

Some one in the organization ought to assume responsibility for these matters and settle them there and then. I think the facts should be looked into and the matter thoroughly investigated and before our customer gets to us with a complaint we have the facts looked into. When the customer comes to me I can make what adjustments are required.—S. B. Morris, Chief Engineer, Water Department, Pasadena, Calif.

I have heard a great many things about meters and I want to tell you something that happened last year to one of our best customers, whose bill jumped from $1 to $15 in a month. He came down to see what was the matter, and we called on the old gentleman and asked him what he had done and he said nothing at all. The next month the bill was still $15. We sent a man out to look at the meter. While he was there a man came along with a load of watermelons, and the old gentleman bought one of these melons. Our man said to him, how do you cool that melon, and he said I set it up in the sink and turn the faucet on and let the water run all night; so he paid his $30 for the two months. We rebate all bills that are too high if it can be shown that there is some reason for it. A customer came into the office the other day and talked to the young man who was in charge. He said his bill was $13 and it had never been over $2.25 before. He wrote a letter to the commission and it was referred to me. He came in and I said to him I understand you are real mad about this. I said sit right down and give me all the excuses you have and when you get through I will begin to talk. He commenced to laugh and he said what do you want me to do. I said I want you to go back to your house, and in the morning I will send our man out and he will take your meter out and take it to the testing plant. If that meter is 2 per cent high we will give you this $13 and if not we will make you pay the whole bill. If the meter is wrong we will not charge you. He did not know about that, and I said, do you know what caused that meter to register that amount of water, because meters seldom make mistakes. We sent the man down and found that the meter registered ¼ of 1 per cent under. We charged him the regular rate and split the difference on the other, and that was perfectly satisfactory. We had one case about five years ago where a man had three houses on one meter, and his bill had been running $15 to $18. We could not find what was wrong and he had his entire pipe line taken up. He finally found there was a leak in his flush tank that nobody knew anything about. I do not believe in giving a rebate for one or two months, because if you tell a man that you will rebate one time, he will come back for a rebate again. Is there any one here who has the system of leaving a card at the residence where the people are not at home, and have the customer fill out the reading of the meter?

There was an old rule in our department to compel our consumers to lay their pipes 18 in. underground in the cellar. That was in the early days. In about 50 per cent of the cellars the soil will vary. We find that leaks will occur in these pipes underground. We had one man who was troubled that way and I thought he should get consideration. Our board has reasonable discretion in matters of that kind and tries to make a uniform 50 per cent allowance, but not the whole bill. We charge the consumer the amount of his former bill and allow him 50 per cent of the excess bill. I believe the bills that are sent out are pretty nearly correct. We have one man who pays a bill of $396 or $450 a quarter without any question. —James Sheehan, Memphis, Tenn.

Acknowledgment.—The foregoing is taken from the November Journal of the American Water Works Association.

Cost of Water Purification at St. Louis, Mo.

In his annual report for the year ending April 1, 1929, August V. Graf, Chief Chemical Engineer, Supply and Purifying Section, gives the following information on the operation of this water purification plant of St. Louis, Mo., for the year.

During the past year 47,269 million gal. of water were pumped into the basins. To this amount of water were added 1.924 tons of sulphate of iron and 15,816 tons of lime, or an average of 0.57 grain per gallon of the former chemical and 4.68 grains per gallon of the latter. Aluminum sulphate to the amount of 171 tons was used at the Coagulant House during the year and the cost of this chemical is included in the cost given for iron.

To the 44,547 million gallons of water filtered were added 4,025 of sulphate of alumina and 218,000 lb. of chlorine, or an average of 1.26 grains per gallon of the sulphate and 4.80 lb. per million gallons of chlorine. All of the aluminum sulphate and part of the chlorine were added before filtration and part of the chlorine after.

The average cost per million gallons for lime was $2.81; sulphate of iron, $0.68; sulphate of alumina, $1.61; chlorine, $0.28. These costs are for chemicals alone, and do not include the costs of handling or application. A comparison of the costs of the various parts of the purification work during the past five years, based on the quantity of water delivered to consumers, is shown in Table I.

Water Works in Wisconsin

Of the 2,631,839 people in Wisconsin, 1,423,989, or approximately 54 per cent, are served from public supplies. A study of the sources of supply shows that 30 municipalities, representing a total population of 755,820, secure their water from surface sources; 13, with a population of 211,762, with complete purification; 16, with a population of 543,207, with partial, and one with a population of 851, with no purification. One hundred and seventy-nine other municipalities, with a population of 483,674, secure their supplies from deep wells, and 73 with a population of 184,495, from shallow wells. All well supplies, except four, serving a combined population of 8,236, are without purification. In these four supplies, the waters have been found polluted and are therefore sterilized with liquid chlorine. While only 30 municipalities secure their water from surface sources, this represents about 53 per cent of the population served from public supplies, while approximately 34 per cent are served from deep wells and 13 per cent from shadow wells, indicating that 29 per cent of the state's population is served with water from surface sources, 18 per cent from deep wells and 7 per cent from shallow wells.

Table I—Cost Per Million Gallons—Based on Consumption 1928-1929

Old Plan	1924-1925	1925-1926	1926-1927	1927-1928	1928-1929
Lime	$ 3.57	$ 3.07	$ 2.53	$2.22	$2.81
Iron	.89	.71	.86	1.07	.68
Unloading	.13	.14	.14	.14	.13
Operating, maintenance and repairs	.66	.61	.60	.61	.65
Water, coal, oil, etc	.08	.11	.09	.09	.08
Light and power	.10	.11	.11	.12	.11
Chemical work and supplies	.48	.45	.50	.64	.59
Basin cleaning	.39	.32	.35	.22	.20
Basin repairing	.16	.27	.13	.12	.15
Switching and demurrage	.25	.23	.19	.22	.17
Total—Old Plant	$ 6.71	$ 6.02	$ 5.50	$5.45	$5.57
Filters					
Aluminum sulphate	$ 2.22	$ 2.11	$ 2.33	$1.87	$1.61
Chlorine	.20	.26	.28	.35	.28
Operating, maintenance and repairs	1.17	1.10	1.14	1.07	1.03
Coal, miscellaneous supplies and expenses	.52	.47	.49	.31	.25
Light and power	.38	.39	.42	.39	.35
Switching and demurrage	.05	.05	.04	.04	.04
Total for filters	$ 4.54	$ 4.38	$ 4.70	$4.08	$3.56
Total for purification	$11.25	$10.40	$10.20	$9.48	$9.13
Total consumption for the year in million gallons	41,283	43,389	43,608	42,263	43,204

Progress in 1929 in the Art of Sewage Disposal

Grit Chambers—Detritus Tanks—Sedimentation Tanks—Aerating Devices—Activated Sludge—Chlorine and Sewage Disposal—Sludge Treatment—High Temperature Digestion—Tendencies in Design

By JOHN R. DOWNES
Associate Editor, Water Works and Sewerage

THIS article is an attempt to indicate the latest developments in the design, construction and operation of sewage disposal works and, also, the trend of thought which will influence the designs of the near future.

It is impossible to precisely cut off, and set apart, each year's progress from that of any other year or to ascribe definite developments to certain persons, because the present status of the art has been arrived at by the exchange of ideas over a long period of time. For instance, Waldo S. Coulter of New York, in speaking of one of his latest developments, is able to trace the idea back to the work of Prof. Chas. Gilman Hyde of California in 1926. Meantime Cohn of Schenectady and Hommon of Canton, O., have worked along the same line. More often ideas are subconsciously absorbed and honestly claimed as original by one person much to the chagrin of another who has been possibly hiding his light. All of which makes an article of this type a precarious undertaking and your indulgence is asked accordingly.

Grit Chambers.—In the past much thought has been given to the design of grit chambers with the idea of making a nice distinction between inorganic grit and readily settleable organic solids. The objects of removing the grit are:

To prevent unnecessary wear on pumps, and fine screens.

To prevent clogging of valves and about the base of sludge pipes.

To make available for active digestion processes, space which would otherwise be occupied by the inert grit.

The object of making a nice distinction between organic and inorganic solids which may be collected in a grit chamber, is to leave the grit in such condition that it may be used for fill, or otherwise disposed of, without its becoming offensive to the olfactory nerves.

A development of 1929 is the realization that much of the organic matter which tends to separate at this point may well be disposed of here with much benefit to the balance of the disposal works. This is particularly true since the art of brewing has been transfered from the public brewery to the private home. The spent mash is very heavy and very acid and productive of the most offensive odors which ever occur about the plant. The mash material is almost the equivalent of sand in its clogging effect. Together with mash, a grit chamber tends to collect a mass of large sized vegetable debris, the kind of material which forms scum blankets on settling tank surfaces.

The difficulty of designing a grit chamber to separate only clean, inorganic sand under the tremendous variations of flow encountered in sewage work is too well known to require comment. The economy and convenience of keeping this heavy organic matter out of the sedimentation tank is just beginning to be realized.

The realization of this situation will result in the hydro-mechanical washing of the comparatively small volume of collected grit instead of trying to control the whole, widely varying flow of sewage to so precise a velocity as is required for the proper classification of the grit.

Screens.—The year 1929 seems to have produced little that is original in the screen line.

Alvord, Burdick and Howson, report the installation of a mechanically cleaned bar screen at Aurora, Ill. In this installation the cleaning mechanism operates only when a predetermined difference of head is established between the two sides of the screen. This screen is on a combined sewer and the mechanism operates once in 4 to 5 minutes during storms and only once in an hour or two at other times. More effective screening is thought to be obtained by allowing material to build up a mat on the screen.

Detritus Tanks.—Developing still further the idea suggested under the heading of "Grit Chambers," there is, at present, a marked tendency to introduce skimming and detritus tanks ahead of the sedimentation units. The leading engineers are introducing this feature in nearly all of their designs for larger plants.

Sedimentation Tanks.—Imhoff tanks are still a feature of a number of large designs by leading engineers. Metcalf and Eddy have included Imhoff tanks in plants for 250,000 persons at Akron, O.; and at Dayton, O., and for 128,000 persons at Allentown, Pa.

More and more attention is being given to distribution of flow in sedimentation tanks by the use of high velocity inlets in place of the old open channels and by the introduction of lattice baffles.

Waldo S. Coulter has reverted to the old septic tank provided with lattice baffles and has interposed between the settling tank and such further treatment as may be provided, a 2-story "trap" tank to intercept solids unloaded by the primary unit. Agitation by dropping the primary tank effluent onto a splash board at the entrance of the trap tank, releases entrained gases and allows the solids to settle.

Mechanical removal of the deposited solids from settling tanks is gaining considerable headway as it is bound to do when we realize the importance of prompt and effective removal both to the quality of the tank effluent and to the efficiency of solid digestion.

Aerating Devices.—As primary oxidizing devices the contact bed and the sand filter seem to be ruled out of the modern picture by the very conditions which impose a demand for sewage disposal; that is to say by density of population and high land value.

The year 1929 finds the sprinkling filter still with us and likely to stay for a few decades. This very useful device with its marvelous recuperative powers and its ability to withstand abuse, has, indeed, had its prospective useful life extended by the very system which for a time seemed destined to replace it. Pre-aeration, not only extends the life of the sprinkling filter, or increases its capacity, but also makes possible the control of such odors as have heretofore been more or less definitely associated with trickling filters.

Trickling filters are features of the larger designs for 1929 by the most prominent engineers and, we believe, rightly so. The trickling filter fly has last its terror, since complete control of this nuisance is possible through systematic filter flooding operations. This flooding, which at first threatened to decrease the overall efficiency of the filters, has been developed to a fine art and now actually increases the year around efficiency and makes the periodic unloading problem much less acute. Needless to add that proper provision for flooding is an essential part of the modern design.

Activated Sludge.—It has been said that success for the activated sludge

system appears to be just around the corner; and yet the largest plants now being designed contemplate the use of activated sludge. This is because local conditions of population and land values activated sludge as the only alternative, and makes it necessary to face the problems of power cost and sludge disposal. These large designs provide very flexible arrangements for sludge disposal and the proper solution seems to be only a matter of time and experience.

Power costs are being cut in a few instances by using the gas from the digesting sludge to operate the air blowers. This method has been in use at Plainfield, N. J., for the past two years for operating the aeration unit in summer.

Chlorine and Sewage Disposal.—Some very valuable information gathered by the Chlorine Institute during the past two years has been put to the test during 1929 and chlorine equipment for prevention of odors has practically become standard.

We now have very definite information about the equation by which chlorine oxidizes volatile and odiferous by-products of sewage decomposition to either non-volatile or non-odiferous compounds. Also, we are able to apply the chlorine at the proper point to prevent the odorous compounds from forming or escaping into the atmosphere.

Sludge Treatment.—So far this article has dealt with the treatment of the liquid portion of the sewage. However, the really difficult part of the problem is still, as it has always been, the reasonable and non-obnoxious disposal of the solid material. Near the close of the present year the announcement was made in Philadelphia that the problem of sludge disposal had been met by the invention of a process for drying and incinerating the raw sludge as it comes from the settling tank.

While this announcement was made with all the authority of the Bureau of Surveys of the City of Philadelphia behind it, engineers who heard it, were frankly skeptical of the economy of drying and incinerating 95 per cent moisture sludge.

True, certain work of the New Jersey Experiment Station had indicated, some time ago, that theoretically there is sufficient fuel available in the green sludge to provide for its drying and incineration. There seem to be many difficulties, however, in making this theoretical fuel value available.

High Temperature Digestion.—While Philadelphia is pursuing this investigation further, the New Jersey Sewage Experiment Station is carrying out experiments on high temperature digestion which promise to reduce the time of digestion from 40 days at 70° F., to 10 or 12 days at about 125° F.

Below is a statement from the laboratory on the present status of this work. The point is, of course, that the per capita allowance of sludge space can be reduced to about one-third that required for controlled digestion at 70° F.

"Investigation on Thermophilic Digestion.—The digestion of settled solids at a temperature range of 115-130 has been accomplished. At this temperature common bacteria capable of growing at ordinary temperatures are killed off and a new group of heat-loving (thermophilic) organisms established. These organisms are present originally in sewage solids in limited numbers in an inactive state. When the temperature is raised to 115-130 these organisms multiply slowly and replace the original flora. When the fresh solids are seeded with ripe sludge produced at low temperatures (70° F.) there is a period of biological adjustment and consequently low rate of activity. Once the thermophilic flora is established the decomposition proceeds rapidly. Thus with sludge produced under thermophilic conditions the digestion of fresh solids has been completed under laboratory conditions in 10 to 12 days at 122° F. The yield of gas and the reduction of volatile matter are somewhat higher while the composition of the gas is similar to that obtained with normal temperatures."

Controlled digestion at 70° F. has become an established and effective practice, cutting the time required for digestion from 100 days plus, to 36 to 40 days. The absolute safety with which the methane gas can be collected under floating covers as used at Springfield, Ill., Elyria, O., Plainfield, N. J., Mammaroneck, N. Y., makes the problem of maintaining the 70° temperature very simple.

Samuel Greeley of Pearse, Greeley and Hansen, Chicago, points to the development of inexpensive winter storage for ripe sludge in connection with controlled, rapid digestion as an outstanding feature of his firm's work.

The provision of inexpensive winter storage of ripe sludge is being accepted as a stop gap pending the development of real winter drying, either mechanically, or on sand beds under cover.

In the combination of rapid digestion followed by cheap storage, the sludge is first digested in a well insulated tank provided with a safety floating cover. Heat is cheaply produced from the gas evolved in the process. After the first 36 to 40 days, the sludge is non-offensive and ready for drying. It may then be removed to uninsulated, uncovered, tanks or to lagoons to await spring drying weather. The cost is far less than can be secured by providing Imhoff digestion compartments for winter storage.

Tendencies in the Art.—This development is in line with the tendency of most of the best engineers to make the new designs flexible so that the plant can be inexpensively enlarged or adapted to new developments as their merits are demonstrated.

A note from Fuller and McClintock indicates that they are giving more and more attention to flexibility in sewage treatment and are tending to divide the process into a number of small steps.

Fuller and McClintock's design for the Wards Island plant for upper New York City provides for sedimentation ahead of activated sludge which seems to be an accepted American practice where activated sludge is used. For the present they provide for barging the sludge to sea, while experimenting with the possibilities of fertilizer production.

This same firm provides for barging sludge to sea in the case of New Haven, Conn. At Tenafly, N. J., they report success with the direct drying of the fresh excess activated sludge under glass.

At Middletown, N. Y., this firm is completing a plant where the sludge will be digested in heated, controlled digestion tanks with safety floating covers and will be dried under glass.

From the southwest, Black & Veatch of Kansas City, Mo., report a trend towards activated sludge in their designs. Preliminary sedimentation is consistently included in these designs, as is controlled digestion of both primary and excess activated sludge.

This firm is struggling with the old problem of effective resedimentation following trickling filters, and at Newton, Kan., have added an equalizing tank with a view to producing a nearly uniform flow in the final tank in place of the surges characteristic of trickling filter discharges.

Alvord, Burdick and Howson report a decided trend toward separate, controlled digestion in all their designs for 1929. They report that at Fond du Lac they are consistently securing approximately two-thirds of a cubic foot of gas per capita with variations from 0.6 to 0.75 cu. ft. per capita. This firm stresses flexibility in its new designs and reports that at Aurora particular attention was given to landscaping and a cheap and effective Spanish stucco type of architecture was used to include all pumping, sedimentation and digestion units under one roof.

Reading of English literature and reports of returned travelers from Germany, give the impression of some bitterness of feeling between the proponents of various types of disposal works in those countries. In this country engineers seem to adopt whatever equipment meets the peculiar needs of a particular locality without prejudice. The free and ready interchange of information among engineers in this country has always been a source of wonder to foreign visitors. The great number of Sewage Associations started during 1929 will further the friendly feeling among workers in the sewage field and lead to still freer interchange of information, much to the benefit of the art.

Leveling for Tunnels and Reservoirs

How Surveys Were Made for the Swift River Reservoir Project of the Boston Metropolitan District Water Supply

By LAROY G. HARRIS

Assistant Engineer, Metropolitan District Water Supply Commission, Barre, Mass.

THE base for the levels run on the Boston Metropolitan District Water Supply Project was established, in connection with the U. S. Coast and Geodetic Survey, by running a series of "precise" or "first order" levels from an established Government bench-mark at Springfield, Mass., along the railroads to Boston via Oakdale, Mass. This established a base line from which circuits and spurs were run in and around the proposed Swift River Reservation Basin and to the various shaft sites along the tunnel line from the Wachusett Reservoir to Swift River.

Bench-Marks.—The following rules were followed strictly:

Permanent bench-marks were established at intervals of approximately 2 miles. The line of levels between two bench-marks was broken by temporary bench-marks into sections from 3,000 to 4,000 ft. long, except where special conditions, such as the extremely hilly country which was encountered on some of the cross-country runs, made shorter sections advisable.

The line of levels is broken in this way in order that an error between two permanent bench-marks can be located without re-running the entire distance of 2 miles. This saves considerable time in case an error is made, especially in hilly country where progress is comparatively slow.

No bench-mark was established and designated as permanent unless it was so fastened in rock, brick, or concrete as to resist extraction, change of elevation, or rotation.

At places from which it is likely that future leveling will be extended, at least three bench-marks should be established within a radius of about ½ mile, or far enough apart not to be affected by the same disturbing cause or causes.

Leveling. — Except when specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and backward directions. It is desirable that the backward measurement on each section should be made under different atmospheric conditions from those which occur on the forward measurement, and this is usually accomplished by making the backward run in the afternoon if the forward run is made in the forenoon, and vice versa.

If the atmospheric conditions seem to remain the same throughout the day, the observer should secure as much difference between the forward and backward runs as is possible without materially delaying the work for that purpose.

On all sections on which the forward and backward runs differ by more than the accepted allowable error, which is generally $0.02\sqrt{K}$ (in which K is the number of miles), the section should be re-run until any two runnings in opposite directions check within the limits of the formula.

The length of sight is usually determined by the topographic and meteorological conditions, but should never exceed 400 ft.

The length of sight between the forward and backward stations should be kept as nearly equal as possible by pacing.

When it is expected that the forward and backward runnings of the line are to be completed up to any one place, the elevation at that place should be held by two temporary bench-marks, established at least one set-up of the instrument apart. When the leveling is continued from or to such a pair of points, the instrument should be set up between them and rod readings taken on each point. The same arrangement of points should be used at the completed end or ends of any detached portion of the line of levels. Either one of the two points may be used for carrying along the elevation, with the other used only as a check against mistakes in reading the rod, or a disturbance of one or both of them. By this method, no mistake of a foot made in reading the rod, held on a bench-mark, will escape detection.

The party consisted of five men: Chief of party, observer, recorder, two rodmen, and an umbrella man. The instrument used was a Berger 3-wire Wye-level. The Molitor rods were used, and these rods have shown, after various tests, that no rod corrections were necessary. Steel turning points were used at all times, except when running along railroad tracks; then common tenpenny wire nails were driven into the ties and the head was used as a turning point. The steel turning point was driven into the ground with the aid of a hammer. After the rod readings were obtained as the back-sight the rear rodman pulled his steel pin and moved forward.

Bench-Marks.—The bench-marks used were of two types, one being a ¾-in. round, brass rod, 6 in. long, rounded on one end. The shank of the rod was threaded for a length of 3 in. These rods were grouted in large boulders, ledge outcrop, and concrete bridge abutments.

The other type of bench-mark was an iron rod about 5 ft. long and bent on one end. A hole approximately 18 in. in diameter was dug in the ground for a depth of 5 ft., and there filled to a depth of at least 18 in. with concrete. The rod was embedded in the concrete in a vertical position, bent end down. After the concrete had set, at least 24 hours, a piece of 2-in. pipe was set around the rod, resting on the concrete, so that the top of the rod was about ½ in. below the top of the pipe. A cap prevented the admission of water, and the hole around the pipe was refilled with earth.

All levels for this work were run during the summer months. It is not generally considered good practice to run precise levels during freezing weather as all tripod legs are fitted with metal points which absorb heat and cause more or less settlement when set on frozen ground. Then, again, it is practically impossible to drive steel pins into frozen ground and steel plates are not wholly dependable, as they will also move if left too long on warm days.

The umbrella is used only when the sun is shining brightly enough to cast a shadow. The idea of the umbrella is to keep the sun's rays from affecting the instrument by expansion. When the instrument is being carried from one station to another it should be protected from the sun by covering it with a cloth or canvas hood.

Equidistant Sights.—When leveling cross-country in hilly territory it is practically impossible to keep the instrument equidistant from the back-sight and fore-sight, but the recorder should keep the observer well informed as to these differences so that he can equalize them as soon as possible. If the fore-sight is, say, 100 ft. longer than the back-sight, then the observer, on the next set up, should shorten up on the fore-sight enough to correct this difference, without any expenditure of time for this particular purpose; so at the end of the run the total lengths of the back-sights should approximately equal those of the fore-sights.

The back-sight is generally taken first and the observer reads all three cross-hairs beginning with the top hair. They are read in feet, tenths, hundredths, and thousandths, and immediately recorded. The fore-sight is read likewise as soon as possible after the back-sight to avoid any possible error due to settlement of

the instrument. The wire intervals are immediately worked out by the recorder, and if they do not differ by more than 0.006, which was selected as a maximum, the instrument was moved ahead to the next station. If the wire intervals differed by more than 0.006, the readings were taken again. On some jobs the wire interval is allowed to vary with the length of sight from 0.004 to 0.010, but they were kept low on this particular work for more or less of an experiment, and the final results showed that the error of closure and the percentage of re-running was kept comparatively low without sacrificing speed.

Progress.—The speed in leveling is greatly dependent upon the activity of the observer, the topography of the ground covered, and the meteorological conditions.

The following tabulation shows the speed attained on this work and is based on levels run in and around the proposed Swift River Reservoir Basin. It does not include levels run along the main line from Springfield to Boston:

Working days	45
Average working hours per day	6.75
Total mileage (including "re-runs")	135.0
Average number of miles per day	3.0
Maximum number of miles any day	7.0
Average number of miles per hour	0.44

The average divergence in the forward and backward runs between adjacent benches on double-run lines was 0.0085 ft., giving an average error of closure of $0.009\sqrt{K}$. The average error of closure for single-run circuits (loops) was $0.01\sqrt{K}$. Of these 135 miles, 7 miles, or approximately 5 per cent, were re-run.

Acknowledgment.—The foregoing is a digest for the December Proceedings of the American Society of Civil Engineers of a paper presented by Mr. Harris at the Fall meeting of the society.

Pacific Northwest Water Works to Meet in April

At a meeting of the board of directors of the Pacific Northwest Section of the American Water Works Association held on Nov. 2nd, 1929, at Portland, Ore., it was decided to hold the next annual meeting on April 24th, 25th and 26th, 1930.

At the present time it is planned to hold a golf tournament on April 24th, the presentation of papers and business meeting on April 25th, the dinner meeting and entertainment on the evening of April 25th, the inspection trip covering the local water system, including trip to the Bull Run Dam and headworks, together with other features, on April 26th.

In connection with this annual meeting the following committees were appointed:

Program: Messrs. W. A. Kunigk, chairman; Carl F. Klapp, and R. E. Koon.

Registration and Reception: Messrs. R. J. Disher, chairman; R. T. Wetteland, Sydney J. Benedict and Chester G. Ehle.

Local Arrangements and Entertainment: Messrs. John S. Beall, chairman; H. M. Chadwick, R. C. Polk and E. N. Hallgren.

Golf: W. B. Severyns, chairman; R. H. Corey, E. W. Thompson and Sam Kerr.

Transportation: H. A. Goode, chairman, and C. J. Wagner.

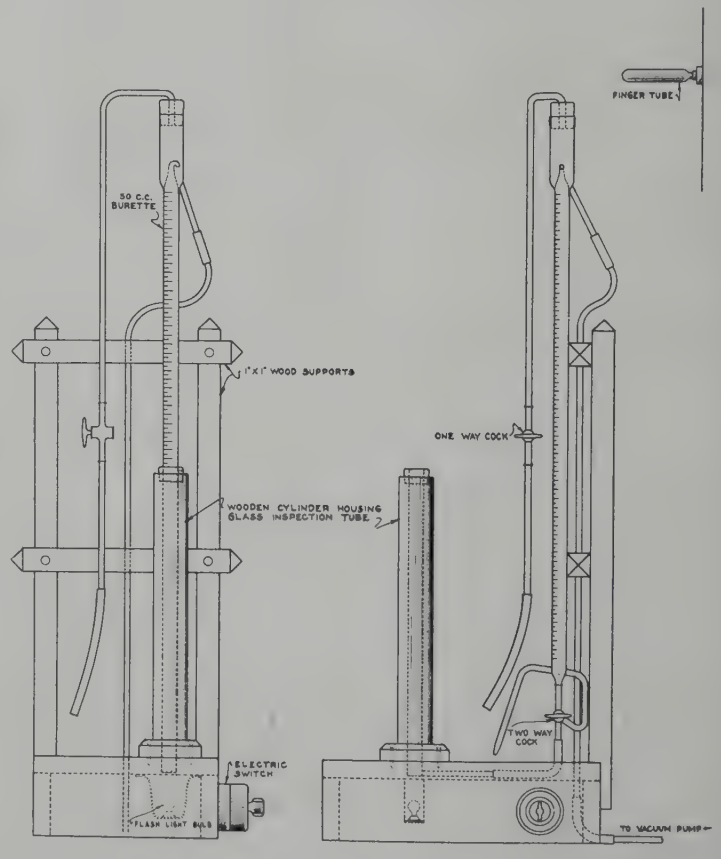
Ernest C. Willard, 720 Corbett Bldg., Portland, Ore., is secretary of the section.

Magnesium Turbidimeter

The hardness of water at the Chain of Rocks filtration plant, of St. Louis, Mo., is calculated from the amounts of calcium and magnesium determined. The method used is that given by Thresh in "Examination of Water & Water Supplies." The calcium is precipitated as oxalate and the amount determined volumetrically. The magnesium is precipitated as magnesium ammonium phosphate and the turbidity produced is determined in the turbidimeter shown. This turbidimeter was designed by F. S. Hawken, Assistant Chemical Engineer. The use of this turbidimeter is described in the last annual report of Leonard A. Day, Water Commissioner of St. Louis.

The sample is drawn, by the vacuum pump, into the burette through the tube connected to the two-way cock. The one-way cock is opened and enough solution is allowed to flow through the two-way cock to fill the small tube connecting the burette to the glass inspection tube. The burette is again filled to the zero mark. The light (a 3.8 volt flashlight bulb in series with a 110 volt, 8 c. p. finger tube) is lit and enough solution is added to obscure the filament of the lamp. This determination is repeated as a check.

A standard containing a known amount of magnesium is precipitated and run at the same time. The standard is so adjusted that practically the same amount of solution is necessary to obscure the filament as is the case with the sample. From the amounts needed to obscure the filament in each case, the amount of magnesium in the sample of water can be computed. This method yields results in practical agreement with those obtained by the gravimetric method.



Details of Magnesium Turbidimeter

Landscape Treatment for Water and Sewage Plants

THE landscaping of the surroundings of water works and sewage disposal plants has been dealt with rather sparsely in engineering literature. At the Third Annual Conference (1929) of the Maryland Water and Sewerage Association three interesting papers were presented on the subject. They are reprinted below.

The Four Dominant Qualities for Landscape Work

By G. W. STEPHENS, JR.
Chief Engineer, The Roland Park Co., Baltimore, Md.

Surroundings of Sewage Plants.—All landscape work, no matter what its size or where it is located, to be a success as an artistic creation must have four dominant qualities, namely, unity, variety, character and finish. The surest way of obtaining the effect aimed at is to be simple in treatment. The true landscape architect aims to produce the best effect by using the smallest variety of kinds in as limited a quantity as possible.

To be permanent, the work must be done step by step in its proper sequence.

Unity.—Professor L. H. Bailey very aptly defines unity as applied to the landscape as follows: "Every planting should be a picture, that is, the area should be set off from every other area, and it should have such character that the observer catches its entire effect and purpose without stopping to analyze its parts. The planting should be one thing, one area, with every feature contributing its part to one strong and homogeneous effect." No one item should be individually conspicuous, but all should help in creating the quiet harmonious whole.

Variety.—When used in this sense I do not mean there should be many kinds of plant material, but there can and should be variety in sky line or contour, in texture of foliage, color, lawn surface, without marring the unity of the place. For instance, while all harsh color contrasts should be avoided, a dash of color here and there among the green can be nicely blended and will add interest. The various characteristic forms of growth, such as horizontal branches against the erect or vertical, make pleasant breaks and give character as well.

Character.—This quality consists largely of being individual or "different" from other places similar in size and outline. It is not easy to define, as the character of a planting is generally the unconscious "touch" of the maker. Just as the "stiffness" or "restfulness" of a room is decided mainly by the appearance and placement of furniture, so character of the planting is dependent on selection and arrangement of material. Each tree or plant should be carefully selected to harmonize, and so placed that it will merge into the general planting scheme.

Finish.—A beautiful planting or lawn cannot retain a permanent, finished effect unless it has the touch of one who is really a lover of plants; one who lives with them, watches their development, and knows their names as well as their appearance. This interest and knowledge is quickly acquired by working among your plants and trees, and personally selecting specimens. Once the flame of enthusiasm has been lighted, you will find yourself observing every planting you pass and taking note of every unusual plant, picturing a place in your planting where it would "just fit." When you have this interest, the shrubbery and flower beds will be kept edged, the lawn kept neatly cut, the hedges evenly clipped, the weeds kept out, and in general, cleanliness and tidiness will prevail. This is the "finish" of the planting.

The sewage treatment plant is commonly thought of as a place to be avoided, and I suppose it is for this reason that so little thought has been given it from a landscape viewpoint.

Heavy screen plantings of flowering shrubs should be used with a few accent points of evergreen trees and shrubs to support the deciduous plantings during the summer and add a touch of life and color during the winter. The buildings should be treated with evergreen and deciduous vines to soften them, and base plantings of flowering shrubs, both evergreen and deciduous, be planted to harmonize with the architecture of the buildings and most important to tie them to the ground.

The walks and roadways within the enclosure of the plant proper and roads leading into the plant reservation should be, in so far as is practicable, curved gracefully to soften the picture and to allow plantings to be made that will screen effectively vistas that may be objectionable from both inside and outside the plant reservation.

Surroundings of Water Plants.—The water plant presents an entirely different problem than the sewage plant. The landscaping of water plants has been given much thought and it is seldom we find the surroundings of them unpleasant.

The small plant as well as the large can be very effectively landscaped with the use of flowering shrubs, both evergreen and deciduous, together with properly arranged perennial and annual borders. By such a combination blooms can be had during all of the summer months and the evergreens will suffice to add the interest needed during the dull months of the winter.

Planting in keeping with the architecture of the buildings is an important part of the landscape setting. Charming planting effects are not the result of chance, but of the studies of men skilled in such matters, who know the soil and the climatic conditions, the growing habits of trees and shrubs, and notably the particular planting scheme to bring out effectively the beauty of architectural styles, and unity, variety, character and finish of the landscape picture most desired.

Important Factors in Landscaping

By M. J. RUARK
Bureau of Sewers, Baltimore, Md.

The following are of importance relative to the landscaping of sewage works:

1. The landscape work where possible should be carried out as part of the initial program, and the cost included in the original estimate;
2. If a sufficient appropriation for the construction of a sewage plant is not available, it is unwise to provide for extensive landscaping at the expense of providing adequate and efficient treatment units;
3. Although it is desirable that a sewage plant be attractive, even under the most favorable conditions it cannot be considered a place for public recreation;
4. Unless funds are available annually for landscape maintenance, this work is likely to result in the forces neglecting operation work in giving more time to cutting of grass, trimming hedges, pruning shrubbery and similar work.

Although the planting of trees and shrubs around and near pumping stations, screen houses and buildings is desirable, such planting, however, should not be placed in the immediate vicinity of trickling filters. Furthermore, narrow strips of grass should not be planted, as they are usually very hard to maintain. While the planting scheme should be attractive, it is doubtful whether there should be any attempt to produce elaborate effects. Dried sludge makes a good filler or substitute for top soil, and there is little difficulty in keeping the grass areas in the vicinity of a sewage plant healthy. On the other hand, the lawns may require

mowing more frequently than in parks, or water-works plants.

Even though funds are not available for a complete scheme of landscaping, nevertheless, rank grass and weeds should be kept cut, swampy areas should be drained, as they provide a breeding place for gnats and mosquitoes, and detract from the appearance of the sewage plant.

The Value of Beauty

By JAS. W. ARMSTRONG
Bureau of Water Supply, Baltimore, Md.

It is important that those entrusted with planning and designing of public improvements should have an appreciation of the value of beauty. The marked improvement in architectural and landscape work in this country in recent years, shows that public taste is gradually reaching a higher plane, and as time goes on the public will demand well designed buildings with attractive surroundings.

Public buildings and grounds are silent witnesses to public taste and have much to do with the standards adopted by private citizens in their places of business and home surroundings. I remember hearing a speaker at a convention describing the influence of good roads on a community. He told of a dirty and neglected street lined with dilapidated and shabby looking houses. The street was repaved with asphalt and almost immediately changes began to take place. Broken window lights were repaired, shutters straightened, painting was started, front yards were cleaned, grass and flowers began to appear, and in the course of a few months the transformation was truly remarkable. All because a conviction had taken hold of them that an attractive and clean street demanded the same kind of homes.

I am making a plea for those who have the planning of public works, to study the aesthetic side of your work along with the utilitarian side.

Lack of funds is the excuse sometimes offered for ugly looking places, but that is generally not the real reason, as good looks can often be secured with little or no added expense.

I have seen buildings and grounds with much money spent on them, obviously for the purpose of adornment, that were ugly; and othere that were made beautiful simply by a skillful massing and proportioning of the buildings and by observing a few simple requirements for planting. If the matter of beauty is not kept in mind during the designing period, it will probably be impossible to remedy the trouble later. I know of a public building recently constructed that was so unsightly that the neighbors complained of it. The officials in charge are now making an effort to remedy the trouble by plantings, but their efforts are too late to ever secure any pleasing effect.

Many city employees inherit ugliness in the surroundings under which they are required to work. Their problem is a very different one from the designee, yet some of the same principles may be applied to the improvement of their places. By the judicious use of a little money and a vision of the possibility of beautifying a place, a plant superintendent may become a real public benefactor.

A few simple suggestions may be of service. An unattractive looking building may be transformed into a thing of beauty by covering it with vines, such as the Boston Ivy or by planting the Boston and English Ivy together, whereby a touch of green may be maintained through the winter. An unsightly building, a coal or ash pile, may be screened from public view by planting closely around it such trees as the Lombardy Poplar, and in front of these may be planted tall growing flowering shrubs, and in front of these shrubs of lesser height. In this way a mass of beautiful foliage can be secured at very little expense. In planting small areas, it is always well to preserve as much lawn surface as possible, and if trees and shrubbery are planted around the borders of the property and in the back ground with occasional plantings against the buildings, a much more attractive appearance will be secured than if the center of the lot were cluttered with trees and bushes.

The unexpected sight of a beautiful tree or cluster of plants or a vista revealing a beautiful view that could not be anticipated always add to the charm of a landscape. The element of surprise which generally enhances beauty can be better secured by making the outline of planning follow irregular curves than by using straight lines. Before an attractive appearance can be secured in some places, it is necessary to regrade the grounds. In such cases, it should be remembered that steep terraces with sharp horizontal lines at the top and bottom are not pleasing to the eye and are seldom found in nature. Gentle slopes with curves at the top and bottom look better, are less expensive to maintain and they also permit the easy operation of lawn mowers.

If terraces must be maintained they can be beautified by the close planting of shrubs. Those who have observed unsightly paths across parks and public squares, know that most people, whether they have studied geometry or not, realize that the "shortest distance between two points is in a straight line." Such paths may be prevented in one of two ways. By plantings that prevent short cuts or by making walks follow the natural lines of travel. Walks following gentle curved lines are more pleasing than straight walks, provided the curves do not give the appearance of being uselessly introduced for effect.

Broad leaved deciduous trees are objectionable for planting around open reservoirs for the reason that the leaves are blown into the water, but pines and other conifers are free from this objection.

Efficient Methods in Private Reforestation Program

The Nekoosa-Edwards Paper Co., which is carrying on an extensive reforestation program in the state of Wisconsin, has found that good organization and large-scale planting bring down costs, according to F. G. Kilp, chief forester, in a paper presented at the 21st annual convention of the Engineering Society of Wisconsin. In 1928, 470 acres were planted at an average total cost of $5.66 an acre. This is a reduction from $6.51 an acre in 1927 and $11.00 in 1926. On large-scale work, 1928 costs averaged as low as $4.18 an acre.

"We prepare our planting ground," says Mr. Kilp, "by plowing furrows every 6 or 7 ft., the spacing depending entirely upon the amount of natural reproduction growth on the ground. A 10-ton Caterpillar tractor pulling a 24-in. brush-breaking plow is used for plowing the ground. The furrows are plowed as shallow as possible, depending entirely upon the underbrush growing on the area to be planted. In general, the depth of furrows is from 3 to 4 in. Oak brush from 1 to 4 in. in diameter has no effect on the plowing or equipment. Between the plowing and crushing effect of the tractor on the brush, from 25 to 40 per cent of the natural competition is removed to assist the seedlings in getting a good start after being planted in the field.

"Experience has taught us that by starting to plow from one corner of a 40-acre section and continuing around and around until the center is reached, our plowing costs are reduced. The former method was to plow clear across and through on the line each time. The new scheme also increases fire protection for several years hence, since the furrows run lengthwise on each side and parallel from opposite sides to the middle.

"The planting crews usually consist of from seven to twelve men and a foreman. Each man carries his own trees in a light box with the roots packed in moss to keep them from dying out, and a spud for planting. It takes several days to organize a crew properly, or to bring it up to its proper efficiency. After a few days of planting experience each man is expected to plant on an average from 2,200 to 2,400 trees a day. It is back-breaking work and only young, strong backs respond to the strenuous daily exercise. Good supervision means, as a rule, good planting survivals."

The New Water Supply of Sioux Falls

New Type of Wells, Iron Removal Plant and Diesel Pumping Equipment

By F. G. GORDON

Gordon & Bulot, Consulting Engineers, Chicago

THE Sioux Falls, S. Dak., water supply is obtained from shallow wells located in the broad river valley of the Big Sioux River, north of the city. From these wells it is pumped to an iron removal plant, and from the reservoir under the iron removal plant by a second pumping into the distribution system. The pumping equipment at the wells is all motor-driven, while the high service pumps are driven by Diesel engines, with the exception of a motor-driven centrifugal pump used for standby service. There are three elevated tanks and one standpipe located on the distribution system.

The sand and gravel stratum from which the water comes apparently covers a very wide area throughout the river bottom. This stratum lies under a top soil approximately 10 ft. deep, and over a dense clay blanket found at a depth of 35 to 40 ft. below the surface.

The present supply comes from two large circular, open wells, each 50 ft. in diameter, and from five closed wells of a type invented and patented by Mr. Maury, the writer's partner up until the time of his retirement from active practice.

The New Wells.—The design of these wells was made with the idea of securing certain results which could not be obtained with any other type of well in use. It was desired to have a well in which horizontal motor-driven centrifugal pumps could be placed, a well which would prevent any contamination in any way, and a well which would have an enormous strainer area. All of these things have been accomplished in the type of well used.

The lower portion of the well shaft has a strainer area extending completely around the circumference, which permits the water to enter the well. The diameter of each well is 18 ft. In each well there are 4,216 2-in. holes, having a total area of 92 sq. ft. Since these holes are distributed around a circumference of 56 ft., 6 in., there is ample opportunity for water to enter the well without excessive friction loss. In order to prevent sand flowing into the well through these large holes, eight pockets are constructed around the inner circumference. The design is such that concrete columns are located between the pocket, thus providing a rigid cylinder. These pockets are filled with fine gravel on the outside face and very coarse gravel away from that face. The fine gravel next to the outside is held in place during the sinking of the well by a screen which is placed on the inner face of the outside plate. On the inner face of the pockets ½-in. steel plates, punched with 1-in. holes, permit the water to enter the well freely. The width of these pockets from the outer face to the inner face is 2 ft.

Immediately above the strainer section of the well is placed a concrete bulkhead. This serves as a floor on which are located the horizontal motor-driven centrifugal pumps. In some of the wells two pumps have been installed, while in others only one pump has been placed. Each well is constructed, however, with two suction pipes, passing through the concrete bulkhead into the strainer area. A third pipe extends through the bulkhead and is carried up to the level of the floor of the well house. This pipe permits measurements to be taken directly to the water level, and is also used for the installation of a Bristol recording water level gauge.

Seven-day charts are used on this gauge, and these charts provide valuable information. They show for each well the ground water level throughout the year. They also show the drawdown of each well when pumping, and the hours that each well pump is operated.

How the Wells Were Constructed.—The manner of constructing one of these wells is quite simple. The top soil at the location of the well is removed and the steel work for the strainer section erected in this hole. The concrete which forms the cutting edge, and the concrete for the triangular columns located between each of the gravel pockets, is next poured. A clamshell or orange peel bucket is then used to excavate from the interior of the well, and as material is excavated, the well sinks. Sixteen gauge steel plates, bolted together with stove bolts, serve as the outside form for the circular well wall. When enough material has been excavated from the interior of the well so that the well has sunk a distance of 4 or 5 ft., a section of wall of that height is poured, the inner forms removed, and the excavation and sinking continued for another four or five feet, when the operation of pouring another ring of concrete is repeated. This process continues until the cutting edge at the bottom of the well reaches the top of the clay, some 35 or 40 ft. below the surface. Water is encountered some 10 or 12 ft. below the surface and the sand and gravel below this point is, of course, removed in the wet.

The well having been sunk to the clay, the next step is the placing of the concrete bulkhead. The wall of the well is so formed that a shelf or ledge exists at the top of the strainer section. A circular form of the cross-section of the interior of the well is assembled on the ground adjacent to the well. Holes are placed in this form at the proper location for the two suction pipes, and the test pipe. The form is then placed immediately over the top of the well and the two suction pipes and the test pipe are inserted through the holes previously made in the form and are bolted to the form so that they are held rigidly in a perpendicular position.

Each of these pipes has a valve at its upper end, which is in the proper position to be about 12 in. off the bulkhead floor when it has been poured. These valves are closed and are covered with burlap or other material and the form, with the suction pipes and valves, is then lowered through the water until it rests on the ledge immediately above the strainer section. Concrete is now deposited on this form by means of closed buckets. These buckets have a bottom door which can be unlatched to allow the concrete to be emptied when the buckets reach the top of the form. By this method the concrete for the bulkhead is deposited under water up to an elevation six inches lower than the finished bulkhead floor level. During this process the water on the inside and the water on the outside of the well are at the same elevation.

The next step in the process is to place a layer of grout on top of the already deposited concrete. While this is being done, the water level on the interior of the well is carried at an elevation higher than the ground water level outside of the well. This difference in hydrostatic head forces the grout into the concrete and insures a water-tight floor. In the five wells of this type which have been constructed for Sioux Falls, no trouble has been experienced in any of these wells in making the floor water-tight.

After the concrete and grout have set up, the water on the inside of the well is pumped out, thus leaving a dry pump pit. The pumps, together with their discharge piping, are then installed, the valves on the suctions are opened, and the pumping equipment is ready for operation. Since the static ground water level is higher at all times than the elevation of the top of the pump casings, these pumps are primed at all times. All of the well pumps are operated from the main pumping station.

Pumps Installed in Rafts.—Rather interesting installations have been

made in Wells 3 and 4. These are the two large circular wells previously described. When first installed each was equipped with a vertical motor-driven deep well pump. The lack of high efficiency of the vertical pumps and the need for an emergency unit for each well suggested the possibility of placing in each well a horizontal motor-driven centrifugal pump on a raft. Rafts were constructed, each consisting of a wooden platform mounted on steel oil barrels. An I-beam was bolted vertically to the interior wall of the well and a yoke, with rollers, was fastened to the raft in such a manner that with a raising or lowering of the water level in the well the rollers move up and down on the inner faces of the outstanding flange of this I-beam. Flexible hose connections are installed from the discharge of the pump to the pipe leading from the well to the iron removal plant. These installations have been in service for twelve years and have required very little attention, outside of an occasional renewal of the hose.

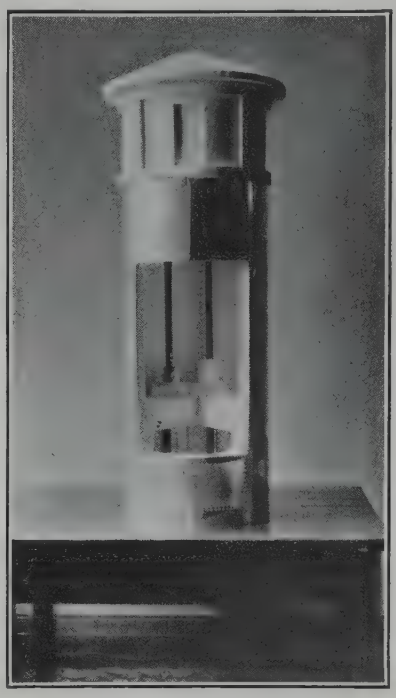
The Iron Removal Plant.—Strict economy dictated the use of several of the more unusual features in the 8-m.g.d. iron removal plant, built at a cost of $11,125 per million gallon capacity. Small filter units permitted hand operation of the valves. Recording water level gauges on the filter effluent line replace the ordinary integrating loss of head gauges. A spent wash water storage sump spreads out the discharge so that a smaller drain answers. The underdrains consist of a steel plate false bottom, into which nozzles are screwed.

Before preparing final plans, an experimental plant was operated to determine whether aeration, followed by sedimentation and filtration but without the use of chemicals, would remove the iron satisfactorily. As the results with the experimental plant indicated a 96 per cent removal, it was decided to employ this process in the contemplated plant.

Rate Controller and Gauges.—A new type of rate controller manufactured by the International Filter Company was used in this installation. This controller is of the Venturi type, with a butterfly valve operated by a diaphragm. Tests, in which the head on the inlet side was varied from 2.5 to 5 lb. in an interval of one minute, showed a variation in discharge of less than 5 per cent.

Recording water level gauges were used for loss of head gauges. The gauges for adjoining filters were mounted back to back on 1-inch gauge boards located on the operating floor. Although this type of gauge is not differential in its action, it gives a satisfactory record because the water level in the filters is carried within a few inches of the same elevation at all times.

Since a single wash water pump is provided, for emergency use a connection is made to one of the high service mains leading from the pumping station to the distribution system. The friction loss through this connection was carefully calculated, and the size of the pipe selected so that the wash water pressure when delivering a sufficient quantity for washing purposes would not be excessive.



Model Showing Construction of Well

A sump having a capacity of 40,000 gal. was constructed to receive the wash water from the filters. The construction of this sump permitted the use of a 10-in. cast-iron drain from the sump to the nearest city sewer instead of the 16-in. drain which would have been required if the sump had not been built. The saving due to the use of the smaller drain amounted to $5,887, while the cost of the sump was only $1,617. Cast-iron construction for the drain was necessary because of its proximity to the gravel stratum from which the water supply is obtained.

The office, laboratory and pump room are located at the front of the filter plant building. The pumping equipment, which is all motor-driven, consists of a wash water pump, three auxiliary low-lift pumps, which can be used as boosters to assist the well pumps during the periods of low ground water, and one high-service pump.

Clear Water Reservoir.—Beneath the iron removal plant is located a clear water reservoir, built several years prior to the construction of the iron removal plant. This reservoir is 116 ft. square and has a capacity of 1,200,000 gal. The construction is of interest in that the floor of the reservoir is composed of a series of inverted groined arches. At the time this reservoir was built the ground water level was some 4 or 5 ft. higher than the bottom of the reservoir and the design was influenced by this fact. The city guaranteed to keep this ground water level down during the construction of the reservoir and was thus able to secure much lower bids than would have been the case had contractors bidding on the work given consideration to this contingency.

The city had four 10-in. wells sunk, one at each corner of the reservoir and connected these wells to a suction pipe leading to one of its high service pumps. By operating this pump during the period of construction, no difficulty was experienced in keeping the ground water level safely below the bottom of the excavation for the reservoir.

After the reservoir had been completed, the four wells were capped with check valves opening in to the reservoir, thus permitting water to flow into the structure whenever the water level on the interior was lower than the ground water level on the outside.

Diesel Engine-Driven Pumps. — In 1915 the city decided to install Diesel engine-driven pumping equipment for regular service, and to relegate its steam-driven pumps to standby or emergency service. Two Busch-Sulzer engines, each of 160 H. P., were selected to drive Aldrich triplex pumps, each having a capacity of 1,600 gal. per minute against 190 ft. head. On each engine shaft was mounted a generator of 135 KVA capacity. A friction clutch installed between the generator and pump permitted the pump to be cut off from the engine and the generator operated as required. These Diesel engine-driven triplex pumps have been in service continuously since their installation and have been entirely satisfactory. In 1926 the city added to its Diesel engine equipment by installing a 400 H. P. McIntosh & Seymour engine, with a 270 Kw. generator mounted on the engine shaft and driving a horizontal Worthington pump through a friction clutch. All of the Diesel engines are of the four-cycle air injection type. Fuel oil is supplied from small tanks overhead which are in turn filled from large steel storage tanks located at the south end of the station building. Cooling water is from the city mains.

Acknowledgment—The above is an abstract of a paper presented before the Missouri Valley Section of the American Water Works Association.

Water Works and Sewers in Illinois.—Of the 1,113 cities, villages and inporated towns in Illinois 508 have public water supplies, and 411 have some form of public sewer system. Of the 411 sewer systems 154 were installed as combined storm and sanitary sewers, 142 as separate sanitary sewers and 115 as mixed systems of sewers and drain tiles.

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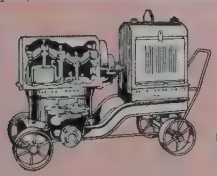

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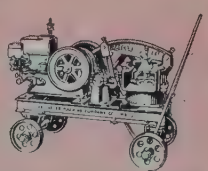

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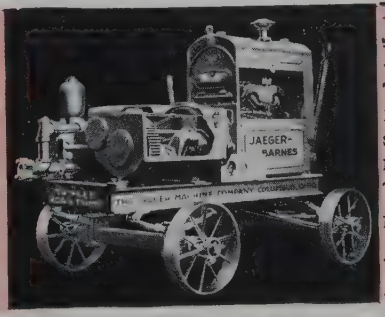

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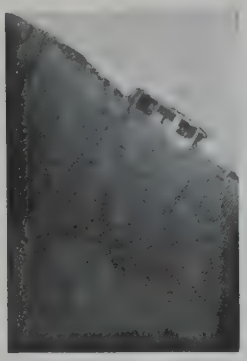
A Trip with our Editor

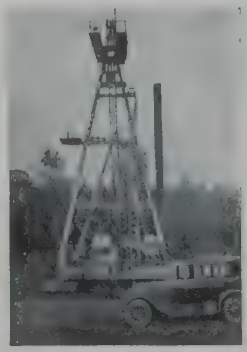


Levee banks make steep going!

Cutting of river bank at end of revetment.

Cypress stumps on right of way. Impassable in car.

Revetment sinking plant.



First tower machine built by the government.

Down the Mississippi wherever levee work is going on, there went the editor. From sun-up to sun-down, driving his car thru places where only tractors should go. Across soft borrow pits; thru cotton fields and sometimes tipped sideways on the slopes of levees, performing stunts which no self-respecting city car should be expected to attempt, on and on he went determined to see as much as possible of work accomplished, and watch government and contract outfits "on the job."

The new program which the government has undertaken involves about $300,000,000. Pictures of this work and graphic descriptions, told by an engineer who understands the nature of it, will make interesting articles for the readers of the Gillette engineering publications, for whose information Mr. V. J. Brown, associate editor, made this journey.

The first article will appear in the November issue of *Engineering and Contracting*.

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Write for particulars

Sources of Water Supply in Southern California

Rainfall—Effect of Altitude on Rainfall—Rainfall Cycles—Disposal of Rainfall—Mountain Runoff —Water Supply from Rainfall on the Valley Floor—Ground Water Basins

By A. L. SONDEREGGER
Consulting Engineer, Los Angeles, Calif.

IT is a matter of general comment among the population of Southern California that of late years we have passed through a period of draught. We have had one dry year after another; in fact, since the great floods of 1914 and 1916, we have had only three years of abnormal rainfall, while the other seven years have been dry. Yet we keep on pumping cheerfully from seemingly unlimited underground sources and nobody appears to worry very much except the superintendent of the water works.

The assertion is sometimes advanced that there are mysterious underground streams, or rivers, which convey water from the Mojave Desert to the Coastal Plain, or from as far distant sources as the Colorado River. There are no indications, or facts, in support of any such contentions. The mountain ranges which separate us from the desert are plutonic in origin. They are many miles in thickness and there are no passages, or cavities, to permit either a flow or a percolation of water across them.

Rainfall.—The water supply of any region in Southern California depends entirely upon the rain falling on its contributary watershed and a study of rainfall phenomena will, therefore disclose the basic factors affecting our water supply.

The major storms which drift from the Pacific Ocean over Southern and Central California are the result of areas of low barometer, usually moving from northwest to southeast. These storms are the most frequent bearers of our rainfall. They are general over the whole region and, as a rule, of fairly uniform relative intensity. The records of seasonal precipitation of any station thus are an index for a broad area.

Effect of Altitude on Rainfall.—The moisture-laden storm winds strike the coast from the southeast, south and southwest. On encountering the mountains along the coast and in the interior, they are forced to rise to higher altitudes, where they are cooled and precipitate a larger portion of their moisture. Thus with increasing altitude, we find correspondingly larger precipitation up to about 6,000 ft., above which there is a slight decrease. This process of absorption of moisture is so effective that after passing the succession of ranges which parallel the coast, there is little moisture left beyond the High Sierras, and the country to the east thereof is naturally barren. This phenomenon is illustrated on Plate 1, which represents a profile transverse to the major axis of the state, from the Coast of San Luis Obispo easterly across the Santa Lucia Range to the San Joaquin Valley and thence over the High Sierras to Owens Valley and Death Valley. This is also illustrated on the same plate by a profile from the coast at Long Beach across the southern Coastal Plain and San Gabriel Valley, passing Mt. Wilson of the Sierra Madre Range and on down to Palmdale in the Mojave Desert.

Rainfall-Cycles.—The rainfall of Southern California is characterized by extreme irregularity, not only from day to day, or month to month of a rainy season, but also from year to year. Yet, while there is an apparent irregularity of seasonal rainfall, it has, nevertheless, been established that within broad limits the fluctuations over long periods of years follow fairly well-defined laws, it being apparent that there are periods of wet years followed by dry periods. The duration of a complete cycle, consisting of a wet and a dry period, is 20 to 24 years; 10 to 12 years in which the average rainfall is above normal, followed by a like period in which it falls below normal.

This phenomenon naturally affects the water supply of the country to the extent that the fundamental problem with which the water supply engineer is confronted, is that of regulating an erratic supply.

Over long periods of years, the consumption of water, through plant growth, corresponds to the average rain. During a series of wet years, with precipitation above normal, there will, therefore, be an accumulation of the surplus water reflected in heavier and deeper saturation of soils, larger stream-flow and rising groundwater levels. An occasional dry year in a wet period will only temporarily check the increase. On the other hand, a dry period will cause the gradual depletion of the water supply. This phenomenon is illustrated in Plate 2, Figs. 1 and 2, which graphically show the seasonal rainfall at Los Angeles and the runoff of the San Gabriel River at Azusa for the years 1871 to 1924.

Fig. 3 of the same plate shows the Mass Diagram, sometimes called "Residual Mass Curve" of the rainfall for Los Angeles, platted so as to show the accumulative effect of the departure from the normal rainfall for the 53-year term. A rising line indicates a rainfall for a season above normal, and a falling line, a shortage. The general downward slope of the dash-and-dotted line denotes shortage over a period of years and consequently a gradual draft on the accumulated water supply, while ascent of the dash-and-dotted line indicates gradual storage of the surplus.

The mass curve then represents what would be the fluctuation of the water level in a tank exposed to the rainfall, from which annually the average amount of precipitation for the 53-year term, namely 15.01 in., is extracted.

A similar illustration is presented in Fig. 4 relating to the seasonal runoff of the San Gabriel River. The mass curve here presents again the fluctuation of the water surface of a reservoir in which the entire runoff would be impounded, with annual abstractions equivalent to the mean recharge for the 53-year term, namely 135,800 acre feet. It should be noted that seasonal fluctuations of stream-flow are much more erratic than those of rainfall. The periods of depletion and accumulation are clearly indicated as follows:

	1871-83 Dry	1883-93 Wet	1893-1904 Dry	1904-16 Wet	1916-24 Dry
Average Seasonal Rainfall at Los Angeles	13.83 in.	20.32 in.	11.25 in.	16.90 in.	12.47 in.
Average Seasonal Runoff San Gabriel River	97,258	224,470	52,427	187,492	120,162
53-Year Mean San Gabriel River 135,800 Acre Feet 100%	138%	89%	72%	165%	39%

The runoff or water supply produced by the San Gabriel River in the driest period of record, 1893-1904, was only 28 per cent of the succeeding wet period. For these two periods, stream gaugings exist for a sufficient number of years to make the results reliable. In order to equalize a water supply like that of the period from 1883 to 1904 to an average of 135,800 acre feet per annum, storage capacity of nearly 1,000,000 acre feet would have to be available, or about four times the capacity of the proposed San Gabriel Reservoir.

Fig. 5, Plate 2, shows the fluctuations of a well at Baldwin Park in San Gabriel Valley for each year. The well responds to the variations in stream-flow and rainfall. The groundwater basin of the San Gabriel Valley is, therefore, comparable to the tank above mentioned, and, as a matter of fact, operates as such. During a wet period

this basin gradually fills with seepage water, both from the streambeds which traverse the valley and from direct percolation of rainfall, so that the water levels in wells keep on rising until this tide turns and the dry period sets in. Inasmuch as it is the function of a reservoir to be drawn down during dry years and to be replenished in wet ones, the lowering of the water-table, as a result of years of drought, does not indicate or prove that the basin is overdrawn. The criterion of an overdraft is the non-return to original levels at the end of a wet period.

The diagrams of Plate 2 show the cyclic fluctuations as determined by observations of rainfall, stream-flow and groundwater levels. In Southern California the water crop of dry periods is supplemented by cyclic underground storage. Dry years are particularly critical for the water users relying upon surface flow. The water supply must be gauged by the dry years crop, and storage is required to regulate the excess flow of wet years. The development of a country based upon the supply of wet periods will sooner or later lead to economic disaster. The present status of the science of astronomy and the related science of meteorology do not permit of periodical weather forecast. Predictions as to our future water supply, therefore, must be based entirely upon records of past performance. Under such conditions, the records of the driest period available, combined with the possibilities of cyclic storage, must be taken into consideration in estimating the available supply, particularly where domestic supply is concerned.

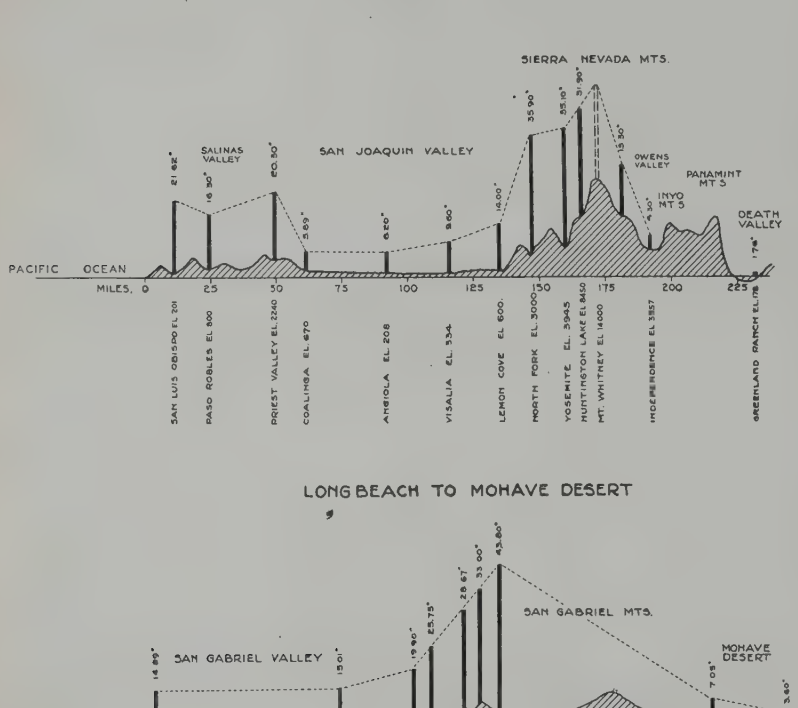


Plate 1—Rainfall Cross Sections Showing Effect of Altitude on Rainfall

Disposal of Rainfall.—Generally speaking, a portion of the rain falling on an area will seep into the ground at the point where it falls; another portion may flow for a distance on the surface or collect into drainage channels, there to seep away unless the storm be heavy enough to produce a runoff on the surface beyond the limits of the watershed, or even as far as tidewater. This "surface runoff," which takes place during a storm or for a few days following, is also termed "storm-runoff."

The rain water which seeps into the ground saturates the soil to various depths, depending upon the magnitude of the storm. This seepage is, in turn, subject first to evaporation from the surface of the ground—second, to a sorption by plant life—and, third, deep percolation beyond the roots plant life and beyond the limits of cap lary action, depending upon soil form tion and moisture conditions. De percolation may subsequently drain to gullies and creeks and thus form t normal flow of a stream which occu between storms and with perenn streams also during the summer. T normal flow of a stream is therefo a seepage-runoff, seeping into t ground first and thence draining the from.

The evaporation and transpirati losses are generally called the "co sumptive use," which is essentially function of the character and type soil and the soil cover.

Rainfall is therefore disposed of "consumptive use," "seepage-runo and "storm-runoff."

This disposal of rain water tak place on the valley floor as well as the mountains, and both types of wat sheds share in the production of water supply.

The relative effect of rainstorms various intensities leads to the conc sion that the largest contributions our water supply are produced storms of great intensity, which la over several days and produce vall rains of 8 in. to 12 in. for the stor Such storms produce a large stor runoff from our mountains. On t other hand, in the valley they are t cause of the deep percolation whi recharges the groundwater basins. study of the effect of individual stor on stream-flow and on the fluctuatio of the groundwater table, will be fou to be very instructive. As a rule, wet winter will produce one storm outstanding intensity, which is respo sible for the greater portion of t watercrop of the season.

Mountain-Runoff.—On a mounta watershed with residual soil cover, see age water may strike bedrock at depth of 1 to 12 ft., or more, there be diverted downhill (see Figs. 3 a 4 of Plate 3). On its downhill cou this percolating water has to run t gauntlet of absorption by the roots trees, brush and herbs which may ha penetrated fissures to depths of 20 30 ft. Abstraction therefore is e tremely active until the percolati water reaches the streambed. Desp this continued tapping, however, see age runoff is produced in dry yea although this may, in part, be due over-year storage and partly to abso tion in talus slides which, owing their unstable and porous formati readily admit the rain water.

The runoff of a mountain watersh is, as a rule, measured at the mou of canyons and includes both the see age, or normal, runoff and the stor runoff. It is the runoff that becom available for water supply. Measu ments of flow on the major streams a made by the U. S. Geological Surv

and the results published in its water supply papers. The runoff figures of the San Gabriel River used in the preparation of Figs. 2 and 4 of Plate 2, were obtained from the water supply papers of the U. S. G. S.

The consumptive use of a mountain watershed for a 12 months season is obtained from the equation

Consumptive Use=Seasonal Rainfall —Runoff.

A study of the daily discharge of a stream and its hydrograph will readily permit the segregation into seepage and storm-runoff, since the latter is characterized by the violent and erratic departures from the more or less uniform normal flow.

For the mountain watersheds it has been found that the consumptive use of the brush or timber cover varies from 20 to 30 in., and that this is, roughly speaking, two-thirds of the rainfall or total water supply. Of the remaining one-third, by far the larger portion is normal or seepage-runoff and only a small part is storm-runoff, except in years of heavy floods. The San Gabriel River, with a watershed of 222 square miles above Azusa, has an average seasonal runoff at that point of 135,800 acre feet, or 600 acre feet per square mile, equivalent to a depth of water spread over the watershed of 11.3 in. The average rainfall on this watershed may be estimated at 31 to 36 in., or about three times the average runoff. For smaller watersheds and lower altitudes, the consumptive use is a still larger percentage of the rainfall and the runoff correspondingly smaller.

The fluctuations of runoff of individual years are even more erratic than the periodical fluctuations. The minimum seasonal runoff of the San Gabriel River occurred in 1898-99 with 9,630 acre feet, equivalent to a depth of water over the whole watershed of less than 1 in., and the maximum in the season of 1921-22, with 410,000 acre feet.

Water Supply from Rainfall on the Valley Floor.—Seepage water penetrating intermittently below the limits of evapo-transpiration activity must ultimately cause the wetting to field capacity (or water capacity), either of the entire formation overlying the water-table, or of well-defined ducts reaching from the surface to the water-table. If there is additional seepage from above, there must be a corresponding addition to the water-table.

The alluvial deposits of which the fill of our valleys is made up are essentially heterogeneous in formation, consisting of irregular bodies of sand, gravel and clay, so that the percolating fluid will naturally find lines of least resistance, to the effect that a uniform saturation over large areas and to great depths is not likely to occur, but rather, the formation of more or less defined ducts.

At points where percolating water strikes an impervious stratum, downward movement is interrupted and a suspended water-table formed. Gradually, lateral percolation is then established and a circuitous route for the percolating fluid is formed until another pervious deposit again permits of more or less vertical movement. Whenever a suspended water-table has been formed, the drainage from same will occur over the edges of the impervious stratum and is likely to collect into trickling streams, as illustrated in Fig. 1, Plate 3. These conclusions are supported by the fact that during the process of excavating shafts in alluvial fills, it is quite common to strike dry materials alternating with moist materials and occasional streams of water.

Inasmuch as alluvial deposits almost invariably show an alternation of pervious and impervious strata, the phenomenon indicated in Fig. 1 is probably the one most commonly encountered. Under such conditions, only a portion of the alluvial mass between the surface and the groundwater table will be saturated.

The recharge of the groundwater may be hastened or delayed by impervious strata. Large clay bodies may not only cause a regulation of an irregular water supply, but they may also provide storage of a magnitude not appreciated because not readily traced.

Absorption is favored by the wedging

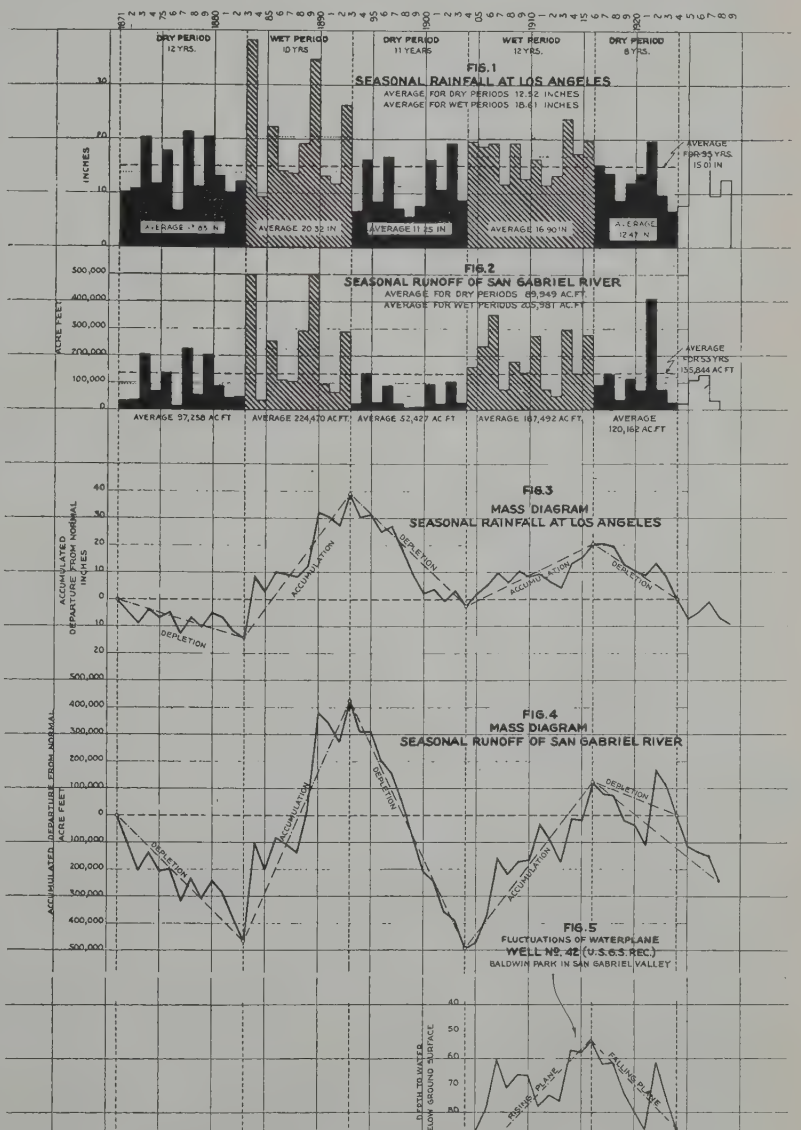


Plate 2—Civic Fluctuations of Water Supply. Averages Computed for Period 1871 to 1924. The Mass Curves of Figs. 3, 4 and 5 Have Been Extended to 1928 to Show the Effect of the Continued Drought

action of roots and especially by decayed roots, the latter having a tendency to drain a saturated mass along defined canals.

The intensity and effect of rainstorms is magnified by the irregularities of topography, whether they are the depth of the root zone, is not likely to occur, with the ultimate result that larger portions of the valley rains reach the water-table than is commonly assumed.

The quantity of the water supply resulting from rainfall on the valley floor

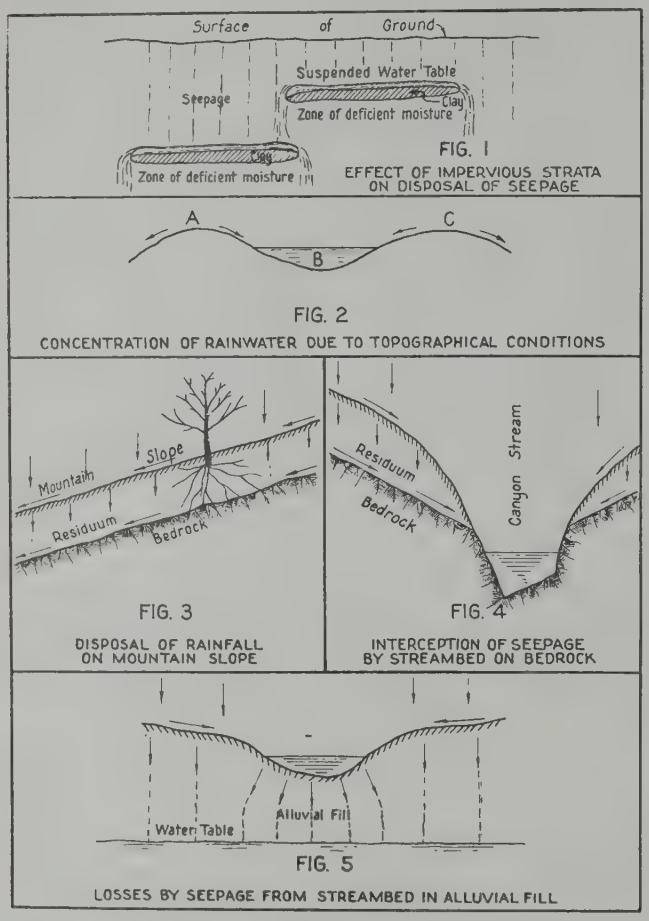


Plate 3

the gentle undulations which occur on an apparently true plane, or hogwallows and hummocky undulations as shown in Fig. 2, Plate 3. It is apparent that some of the rain falling on Points "A" and "C" will flow on the surface to the depression "B." A 3-in. rain may produce at "B" a depth of water of as much as 6 in. and a seepage greatly in excess of that at points "A" and "C." This concentration of rain water, therefore, induces a corresponding concentration of seepage and may be responsible, in part, for deep penetration when the seasonal rainfall uniformly absorbed is not sufficient to satisfy the moisture deficiency and evapotranspiration losses over large areas.

It is therefore concluded that the irregularities of topography, the heterogeneous character of alluvial soils and the actions of roots all tend to concentrate percolation along lines of least resistance and that a uniform wetting of the soil over large areas, even to is not readily ascertained and for this reason has, in the past, often been underestimated. The author has made extensive studies of this phenomenon, and his conclusions have been confirmed by the investigations of the engineers of the U. S. Department of Agriculture and State Department of Engineering.

In the San Bernardino Valley, above the lower Santa Ana Canyon, it has been determined that in certain years as much as 40 per cent of the total watercrop tributary to that valley is from rainfall on the valley floor, and that the contributions from this source exceed 200 acre feet per square mile.

It goes without further explanation that the gentle rains and light storms of dry years do not produce deep penetration to any extent. It is the rainfall of normal, and particularly of wet years with their heavy storms, that causes a substantial recharge of groundwater basins, which can be observed in the response of the water levels in wells. Where clay strata are extensive, this response is lagging, but nevertheless ascertainable. The average proportion of recoverable voids in alluvial materials is about 15 per cent, a rise of the watertable by 1 ft. over an area of 1 square mile would indicate a recharge of 96 acre feet, equivalent to a depth of 1.8 surface inches of water.

Groundwater Basins.—Even the casual observer will notice that Southern California is dotted with thousands of wells, operated by pumping plants. Probably 75 per cent of the water supply of this country is derived from underground sources. The drilling of great numbers of wells has disclosed that the principal valleys, from the San Luis Rey River northerly to the Sierra Madre Mountains, are underlain by deep basins filled with alluvial materials. Having been laid down by flowing streams, these deposits are arranged irregularly, with kidneys of clay interlaced with lenses of gravel or sand. The latter are the water-bearing gravels, which, under favorable conditions, may carry as much as one-third of voids, or interstices, which are filled with water; this water, in turn, being subject to abstraction by means of wells and pumps. The valleys, or basins, are shown on Plate 4.

The entire San Fernando Valley is underlain by such a basin, as is the San Gabriel Valley, the Coastal Plain from Santa Monica down to Newport, the San Bernardino Valley, San Jacinto Valley, etc. The storage capacity of these basins is so enormous that the capacity of surface reservoirs, even of the size of the San Gabriel Canyon Reservoir, is but a fraction thereof. The recharge of these basins is effected by seepage from streams which cross the valleys, and from rain water seeping into the ground of the valley floor and beyond the roots of plant life, ultimately to reach the water-table. The groundwater, sometimes called the "underflow," percolates, as a rule, in the general direction of the surface stream. The rate of percolation is generally slow, ranging from 1 to 3 or 4 miles per year. Unless intercepted by barriers, the underflow will, in its natural course, reach the ocean underground.

A characteristic of most of these basins is the occurrence of underground barriers (dikes) or of lateral constrictions, or both, which interrupt the percolation of the groundwater streams. Taking, for example, the San Fernando Valley. At Van Nuys the valley has a width of 8 miles and a depth to bedrock of 1,000 ft. or more. At its outlet the valley is constricted from Burbank to Elysian Park by the approach from either side of the hill formation, narrowing the valley down to a width of ¾ mile. This is the Elysian Park "Narrows." There is, furthermore, an underground sandstone barrier which crosses the narrows at a depth of less than 200 ft. below the surface. The

combined effect of lateral constriction and barrier is to force the groundwater to the surface and to form the rising stream of the Los Angeles River. This river begins as a small stream in the vicinity of Van Nuys and gradually increases on its course toward the Narrows to a flow of 40 to 50 sec. ft., even in the summer months of a dry period. The Los Angeles River is therefore strictly a groundwater stream (except for its flood flow). In order to prevent pollution, the river is now drained by infiltration pipe lines, from whence it is conveyed to the city.

San Gabriel Valley extends from Pasadena to San Dimas, a distance of some 20 miles, and has a depth of alluvial fill of over 1,000 ft. At the Whittier Narrows the valley is constricted to a width of about two miles. The depth of fill at this point is about 480 ft. The effect of the "narrows" is a stream of rising water, beginning about at the Foothill Blvd. with a small stream and increasing, as the Mission St. bridge is approached, to a river carrying 60 to 120 sec. ft. This supply is diverted in a number of irrigation ditches.

The many narrows constricting our valleys, or basins, are indicated on Plate 4.

In the groundwater basins water will remain pure and potable for indefinite periods and is available for abstraction over long periods as it percolates from the mountains to the sea.

These groundwater basins present a natural and practical solution for the regulation of the otherwise erratic water supply of Southern California, making it possible to store water from a wet period into a dry period; in other words, permitting of a cyclic regulation of water supply. For this reason they are the fundamental physical factor which made possible the development of this country.

Too much emphasis cannot be placed on the economic importance of the deep gravel beds which underlie our valleys. The layman is inclined to lay stress on surface storage, believing that the water problem can be solved by the construction of surface reservoirs. The proper function of our flood control and conservation reservoirs is that of detaining floods. From such temporary storage and flood-waters may conveniently be carried on to the gravel deposits below the mouths of canyons and there caused to sink into the ground, to become a portion of the groundwater underlying our valleys. This method of conservation is also known as the spreading of flood-waters and is now practiced on practically all rivers and streams of Southern California.

Mr. William Mulholland, who might appropriately be called "The Father of Southern California Water Supply," many years ago realized the value of groundwater storage. When planning the Owens River Aqueduct, Mr. Mulholland took advantage of the underground possibilities of San Fernando Valley. In order to dispose of surplus aqueduct water, an irrigation system was planned for this valley and about 60,000 acres are now irrigated from this source. The seepage, or return water, from this irrigation, which reaches the groundwater basin underlying the valley, is estimated at about 25 per cent of the water applied. As a result of 10 to 12 years of irrigation, the groundwater levels in San Fernando Valley have risen in the face of a series of dry years and the flow of the Los Angeles River, which, at the end of a dry period as exists today, would flow from 40 to 50 sec. ft. at the Narrows, now discharges over 80 sec. ft., all of which is rising groundwater. This water is diverted by gravity for domestic use in Los Angeles. Thus a natural process, ingenious in its simplicity, has deliberately been taken advantage of and a gravity supply recovered at the gates of the city, which is conservatively estimated to be worth $3,000 per miner's inch, or, in round figures, $5,000,000.

Literature on Local Water Supply

Water Supply Papers of the U. S. G. S. by W. G. Mendenhall.

No. 137—Development of Underground Waters—Eastern Coastal Plain, Southern California.

No. 138—Development of Underground Waters—Central Coastal Plain, Southern California.

No. 139—Development of Underground Waters—Western Coastal Plain, Southern California.

No. 219—Groundwater and Irrigation Enterprises in the Foothill Belt of Southern California.

These papers, although written about 25 years ago, are still considered as presenting by far the best studies on Southern California groundwaters and are recommended to those interested in the subject.

Bulletin No. 5—Flow in California Streams. By State Department of Engineering, giving records of rainfall and stream runoff and estimated water supply of the State of California.

Bulletin No. 6—San Gabriel Investigations of State Department of Engineering, by Harold Conkling.

Proceedings, American Society of Civil Engineers, May, 1929.

Water Supply from Rainfall on Valley Floor, by A. L. Sonderegger, refers to Southern California conditions.

Acknowledgment.—The foregoing is a paper presented before the Water Supply Section at the 1929 Short Course in School of Citizenship and Public Administration held June 17-21, at the University of Southern California, Los Angeles.

Ohio Sewage Treatment Conference

The third annual Ohio Conference on Sewage Treatment was held Oct. 22 and 23 at Canton, O., with a registered attendance of 105. Two half-day sessions were held, with Charles C. Hommon, of Canton, presiding.

Subjects discussed were: The Canton Sewage Treatment Works, the Salem Sewage Treatment Works, the Ohio Sewer Rental Law, Sewage Disposal Litigation, Operating Small Sewage Treatment Works, and the Biological Oxygen Demand Test. Excellent motion pictures of the Salem Plant were presented.

Officers elected for the ensuing year were: Floyd G. Browne, Marion, chairman; T. C. Schaetzle, Akron, vice chairman; M. W. Tatlock, Dayton, secretary-treasurer; O. F. Schoepfle, Sandusky, member-at-large of the Executive Committee.
mittee.

A cordial invitation was received from Dayton to hold the 1930 conference in that city.

Plate 4

The Dewatering of Fine Screenings

Practice at Various Sewage Disposal Plants in Dewatering Screenings by Pressing and by Centrifuging

By KENNETH ALLEN

Sanitary Engineer, Board of Estimate and Apportionment, New York City

DISPOSAL of sewage screenings is not often a difficult problem in the case of a small installation and where there is land available where they can be buried in trenches, plowed under or merely covered, to prevent odors, fly breeding, etc.; but as the volume increases and land becomes more restricted it presents difficulties that may be very perplexing.

Character and Amount of Screenings.—The character and the amount of screenings per million gallons of sewage naturally varies between wide limits with the character of the sewage and the fineness of the screen. At one plant there will be found a large percentage of paper; at another fecal matter will predominate; at another vegetable kitchen wastes and at another sticks, twigs and leaves, depending on the season. With a normal domestic sewage the screenings will be composed largely of paper and feces, both of which will diminish in amount in stale sewage by disintegration.

In general the fine screenings from normal city sewage usually amount to 15 to 25 cu. ft. per m.g. sewage, weigh 50 to 60 lb. per cu. ft. and contain 75 to 90 per cent water and 80 to 90 per cent volatile matter (dry basis). They are generally so wet as to be "sloppy" but can be handled with a spade.

They are difficult to burn when containing over 70 to 75 per cent moisture and the greater the reduction in this percentage the longer they may be stored without giving off objectionable odors and the more readily is combustion effected.

Methods of Disposal.—Screenings can be disposed of with due regard to sanitation:

(a) By burying in trenches prepared in advance.

(b) By mixing and disposing of with the city garbage.

(c) By digesting, spreading and plowing under.

(d) By dewatering and burying, plowing under or burning.

Burying, in the case of all but small plants, is open to the objection that it requires considerable land and manual labor.

Disposal with garbage is often the most practicable method, but where it is to be incinerated the moisture content demands a thorough mixing with sufficient added combustible rubbish.

Digested screenings are relatively inoffensive, and although containing perhaps 95 per cent moisture, may be disposed of by drying on beds to about 70 per cent moisture, by spreading on the land and plowing under or merely used as fill.

At the Milwaukee works experiments in digesting screenings have been carried on for over a year and others, on screenings from Plainfield, have been made by Dr. Rudolfs at the New Jersey State Agricultural Experiment Station, both with the possibility of success if carried out under proper control. Careful, competent supervision appears to be necessary to bring about active and inoffensive decomposition, involving the proper seeding, temperature and pH control. Moreover, suitable provision for final disposal by drying or otherwise, involving additional land, must be made and in a built-up section this may not be practical. For these reasons some method of rapid preliminary dewatering to not over 70 per cent moisture seems desirable in the majority of cases. There are two general methods of accomplishing this: (1) by pressing, and (2) by centrifuging.

Methods of Dewatering. — Coarse screenings from racks, cages, etc., have been pressed at a number of plants for a good many years. The presses have usually been of the "cider" type, operated by hand or by hydraulic power.

At Washington a hydraulic press of this type, 24 in. in diameter, was installed in 1906, operating under a pressure of 105 to 115 lb. per sq. in., requiring two men for each 8-hour shift. It is understood that this press has stood up well under service and given good satisfaction. In the fiscal year, ending June 30, 1929, 1,905,839 lb. screenings were pressed, varying from 4,153 to 7,974 lb. and averaging 5,221 lb. per day, the weights being of the dewatered material, which contained about 85 per cent moisture.

Favorable results were secured at Washington where coarse screenings were put through a hydraulic press and then burned in a small Decarie incinerator used as a hot water heater for the building. Their volume was reduced about 60 per cent in the press. About three pressings were made per hour during dry weather conditions of flow, when the weight of pressed screenings per 24 hours varied from 2,800 to 3,100 lb. About 200 lb. coal was required to start the fire at the beginning of each shift, or 0.2 lb. coal per lb. pressed screenings.

A similar press, but operated by both steam and hydraulic power, was installed at Boston at the Calf Pasture pumping station in 1912. This required the attention of but one man while handling one to four charges per hour. The dewatered material was burned without difficulty. The press here is understood to have proved unsatisfactory.

At the Ward Street pumping station a steam-operated press, 24 in. by 18 in. diameter, has more recently been installed. The screenings, dewatered to 65 per cent to 75 per cent moisture, are burned under the boilers of the plant.* A press of this kind, operated by steam or hydraulic power, will handle about 500 cu. ft. wet screenings per day and cost in the neighborhood of $3,000.

Dewatering Fine Screenings.—There has been little experience as yet in the dewatering of fine screenings. With the larger amount of fine organic material their water content is probably given up somewhat less readily than from coarse screenings but from what has already been accomplished and with the more extensive experience in dewatering sludge the question of dewatering fine screenings may be considered a matter of detail.

Fine screenings have been dewatered for several years by pressing in the Borough of Queens at three plants in the vicinity of Flushing Bay. The screenings are then burned in small oil-burning "incinerites." A test of one of these, located at Corona, was made in 1920. The screenings were placed in the hand press and left to drain for 19 hours when they were removed and burned. The 2.78 cu. ft. pressed screenings contained 69 per cent moisture, weighed 52.0 lb. per cu. ft. and were consumed in three hours with a loss of 93 per cent weight, for which 0.018 gal. of oil was required per pound dewatered screenings. By care in firing these small installations are quite satisfactory.

In 1914 the city of Baltimore installed a 24-in. press similar to that at the Calf Pasture pumping station at Boston. Pressures here were carried as high as 170 lb. per sq. in. Four-and-one-half baskets were charged per hour, requiring the attention of two men. In spite of the pressures used the moisture in the product was too great for easy burning, possibly due to the high rate of operation.

In 1921 three more presses of the same type were installed at the main

*If they are so sloppy as to be forced through the perforations of the basket a small quantity of shavings are added to absorb the excess moisture. Two men are required for operation on each shift.

Sewage Treatment Plant at Oyster Bay, N. Y.

sewage pumping station. Four pressings per hour can be made with these if necessary. By measurement about 3 cu. ft. dewatered screenings were produced from each of 48 pressings per day from a sewage flow of 25 m.g. As these wighed 60 lb. per cu. ft., the total output amounted to about 8,000 lb. per day. To burn this required about 1,600 lb. of coal.

In 1926 C. E. Keefer made tests in pressing the screenings at the Eastern Avenue sewage pumping station.†

Average Results

	Unpressed Screenings	Pressed Screenings
Cubic feet per m.g. sewage	7.75	4.04
Pounds per cu. ft.	60.17	50.03
Per cent moisture	86.45	72.19
Coal used for incineration:		
Lb. per cu. ft. screenings		11.07
Per cent reduction in volume by pressing		47.85

The estimated cost of a pressing and incinerating plant to dispose of the screenings at this station was:

For: Building	$3,540
Incinerator, chimney, etc.	1,800
Press	3,600
Total	$8,940

and the annual cost was:

For: Fixed charges		$ 894
Operation:		
Coal (97 tons)	$626	
Power for press	10	
Removal of ashes	20	
		656
Total		$1,550

As a result of these tests it was decided to continue this method of disposal.

Experiments in pressing screenings were made by Mr. Keefer at the Back River disposal plant, Baltimore, in 1927, using a cider-type press operated by steam under 175 lb. per sq. in. pressure. The press was manufactured by the Coffin Valve Co., and cost, in 1919, $2,785. The screenings averaged 7.75 cu. ft. per m.g. sewage and contained about 86 per cent moisture, which was reduced to 72 per cent, with a reduction of 48 per cent in volume by the operation.

†Proc. Am. Soc. C.S., Sept., 1929. The flow handled at this station averaged 25 m.g.d. in 1925.

Dallas, Texas, installed a 19-in. hydraulic press in 1915. With a pressure of 60 lb. per sq. in., four to eight baskets of screenings were pressed per 24 hours sufficiently to burn readily under a boiler. The only attention required was that of the boiler room helper. The operation of this press is said to have been satisfactory.

At Milwaukee it was attempted to press the fine screenings in a Berrigan press. This proved quite feasible, but was finally abandoned as too costly.

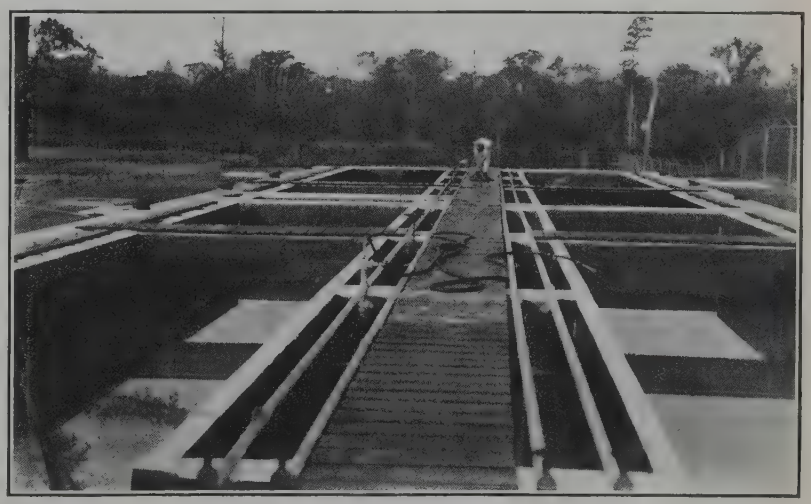
A plant designed by Metcalf & Eddy is now being installed at Dayton, Ohio, in which the screenings from a Dorrco screen with ⅛-in. slots will be dewatered in presses made by the Hydraulic Press Mfg. Co. and then burned in a specially designed incinerator. It is estimated that the moisture content of fine screenings from 26 m.g.d. sewage will be reduced from 85 per cent to 65 per cent by placing them in slotted baskets and compressing under a hydraulic plunger. The 230 cu. ft. dewatered material produced per day will then be burned together with screenings from a 4-in. rack 80 per cent moisture and skimmings 75 per cent moisture.

From the foregoing it is safe to conclude that normal screenings, whether from coarse or fine screens, may be dewatered in a press of proper design to such an extent as to be disposed of by burning under boilers, in a garbage incinerator or in an incinerator specially designed for the purpose, with little additional fuel. At Baltimore the life of a press of the cider type has been found to be about eight years. These are generally of 24-in. or 26-in. diameter, operated under a pressure of 150 lb. per sq. in. and compress the screenings to half their original volume.

Experience with wet screenings has not been so convincing, although these are burned in a few places.

At Miami, Fla., about 40 cu. ft. per day of screenings, averaging 50 lb. per cu. ft., are successfully disposed of by incineration in a Nye odorless incinerator without additional fuel and without odor after pressing under a dead weight of 500 lb. They are stored in covered garbage cans until night, when they are hauled to the incinerator. This is located in a residential section.

The fine screenings at Rye, N. Y., Long Beach, Calif., and coarse screenings at Canton, O., are disposed of without pressing; at Rye in an adjacent Morse-Boulger incinerator with the village garbage, and at Long Beach and Canton in incinerators designed for the plant. At Long Beach 47.7 cu. ft. screenings per day about 80 per cent moisture are successfully burned in a dutch-oven furnace with 21,300 cu. ft. natural gas. At Canton about 27 cu. ft. screenings of similar water content are incinerated daily after an hour's draining in perforated cans, together with an average of about five dead animals, with the use of about ten tons of coal a month. At the Jamaica plant, Borough of Queens, the 5 cu. ft. fine screenings per m.g. from a flow of about 10 m.g.d. of sewage contained 87 per cent mois-



View of Portion of Sewage Disposal Plant at Teaneck, N. J.

ture. The attempt to dispose of these wet screenings with the city refuse in a 150-ton incinerator did not prove satisfactory.

Centrifuging.—There is no reason to suppose that screenings as well as sludge may not be dewatered by centrifuging. The smaller volume of foul drainage liquor would present a less serious problem and it is quite possible that a less expensive type of centrifuge than the Bescoter-Meer might answer the purpose. Very little has been attempted in this line but as the number of screening installations increases it is possible that this method of dewatering may be found practicable.

At Reading, Pa., screenings from a fine-mesh "Weand" screen were placed in canvas bags and dewatered by a centrifugal "hydro-extractor," about 6-in. diameter by 3 ft. 6 in. high, which reduced the moisture in a charge of 500 lb. from 85-90 per cent to 61-73 per cent moisture in eight minutes. Its weight was reduced from 65-70 lb. to 30-35 lb. per cu. ft. by the process, when it contained about 72 per cent volatile matter. It was then burned under the boiler at the plant. The plant was rebuilt some years ago and the screen abandoned.

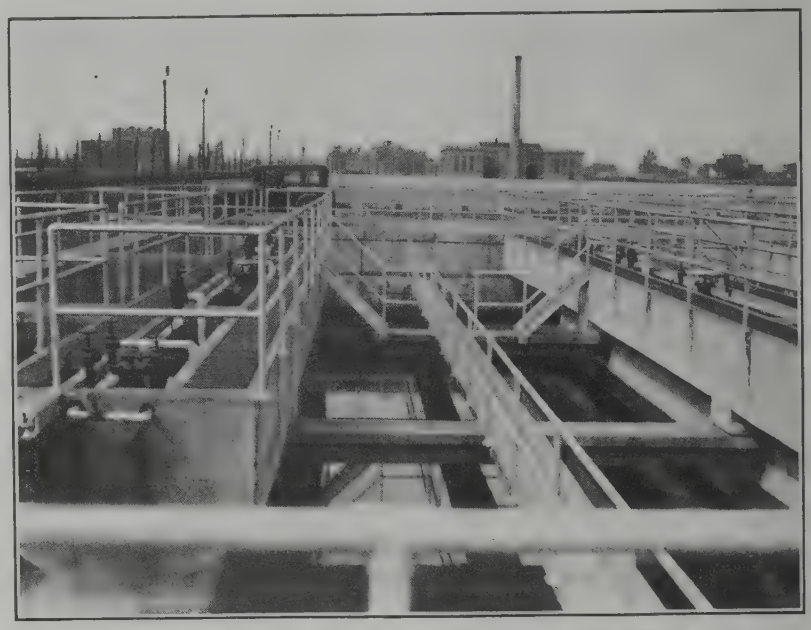
Experiments were conducted by George G. Gascoigne at Cleveland in which about 1¼ tons of fine screenings, 85 per cent moisture, after a brief period of draining, were placed in burlap bags and dewatered in a "Laundryette" centrifuge. The moisture was reduced to 65 per cent and screenings burned in a small "Kewanee" incinerator by adding about 25 per cent of coal by weight. The incinerator had a nominal capacity of 300 lb. screenings per hour, 90 per cent moisture. Some smoke and odor were given off, but no complaints were recorded.

Screenings were burned under a "Sims" boiler for a while at the Easterly Works several years ago after dewatering in a "Troy" centrifuge, but some odor resulted and the practice has been given up.

At Baltimore tests of a sludge centrifuge made by the Hanomag Co. of Germany indicated that the passages were too small to function properly with screenings.

Centrifuges, belt-driven or direct-connected, are on the market that may prove adapted to service of this nature. They generally consist of a perforated basket, 30-in. to 40-in. in diameter, in which the screenings are placed and which rotates at speeds as high as 900 r.p.m., the drainage liquor being let off by a pipe. To unload, the basket is raised, moved to one side and dumped by rotation on trunnions. In one type there is a counterbalanced "unloader" which, by a slow rotation, scrapes the cake gradually from the top down. The material thus loosened falls through a port in the centre of the bottom, provided with a cone valve, to a conveyor or truck.

The first cost of a 40-in. centrifuge is about the same as that of a press. Operation is largely automatic, requiring but one man, but a fair comparison with presses, which have more often been used, cannot be made at this time.



View of Portion of Northeast Sewage Disposal Plant, Philadelphia, Pa.

Amount and Character of Fine Screenings

Location	Opening	Screenings Per M.G. Cu. Ft.	Per Cu. Ft. Lb.	Moisture Lb. Per Cent	Volatile Per Cent
Brooklyn, N. Y.—					
26th Ward	5/64 in.	8 8	.....	82	83
26th Ward	1/16 in.	7.5	.....	80	81
26th Ward	3/64 in.	5.7	.....	86.8	93.5
26th Ward	1/32 in.	5.2	.....	77	68
Los Angeles, Cal.—					
N. Hyperion	1/16 in.	16.5	.....	87	....
Long Beach, Cal.	1/32 in.	27	1,810 67	87	....
Remodelled	1/16 in.	.....	2,485	75.85	....
Milwaukee, Wis.	3/32 in.	7—8	315	86—90	....
Experimental	⅛ in.	21	985 47	88	....
Pasadena, Cal.	1/16 in.	30	.....	88	....
Plainfield, N. J.	1/16 in.	15.8	.....	89	....
Plainfield, N. J.	¼ in.	5.67	261 46	84	....
New York—					
Dyckman St.	3/64 in.	27.1	1,449 53.4	78	88
Dyckman St.	1/16 in.	18.4	1,040 56.5	82	91
New Britain, Conn.	1/16 in.	30	2,020 67.3	81	....
Reading, Pa.	1/30 in.—1/36 in.	31	.....	89.5	....
Reading, Pa.	.014 in.	25	1.500 60	89 5	73
Brockton, Mass.	.0214 in.	38	1,990 52	71	....
Guildford, Eng.	.25 in.	9.3	370 40	75	....
Burton, Eng.	.38 in.	9.5	380 40	75	....
Bromberg, Poland	.08 in.	13.4	870 65	85	....
Leeds, Eng.	.125 in.	36	1,080 30	....	....
Leipsig, Ger.	.31 in.	2	80 40	75	....
Columbus, Ohio	.375 in.	4.6	300 65	....	....
Croydon, Eng.	.4 in.	14 6	583 40	75	....
Frankfort, Ger.	.4 in.	15.8	635 40	....	....
Elberfield, Ger.	.4 in.	21.6	865 40	70	....
Göttingen, Ger.	.4 in.	14.7	337 23	83	....
Dresden, Ger.	.08 in.	26.2	....	84	....
Strassburg, France	.10 in.	43	....	89.3	....
Tier, Ger.	.10 in.	8.6	....	55	....
Temesvar, Roumania	.12 in.	35.1	....	65	....
Keansburg, N. J.	3/64 in.	44	 60	....	....
Cleveland, Ohio	1/50 in.	.....	858	94	73
Experimental	1/80 in.	.....	674	90	64
Experimental	1/120 in.	.....	682	86	72

Conclusions.—Dewatering screenings to an extent when they may be burned without difficulty may be accomplished by pressing and probably by centrifuging. With the increasing number of screening plants and a growing insistence on hygienic conditions this method for their final disposal seems likely to develop in the future.

In conclusion the author desires to acknowledge as the source of much valuable information that he has freely drawn upon in the preparation of this paper, the following gentlemen: Major D. A. Davison, U. S. A., also Robert Cramer, George B. Gascoigne, Charles C. Hommon, J. E. Jewett, F. B. Jones, C. E. Keefer, W. T. Knowlton, F. A. Marston, Langdon Pearse, Asa E. Phillips, W. M. Pratt, Harry L. Shaner, Ralph Van Duyne and W. W. Young. Thanks are also due the several manufacturers of dewatering machinery and incinerators for details concerning their

devices that have been kindly furnished.

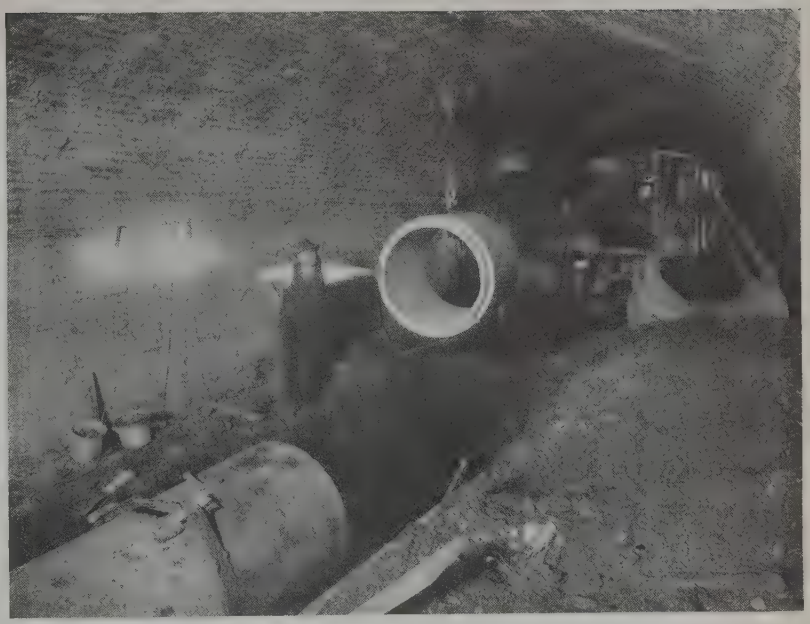
The application of devices for filtering or straining slimes or sludges has not been discussed in this paper, for although some of them may prove valuable for the dewatering of screenings reliable information as to results obtained has not yet been obtained. In one experiment, however, by Filtration Engineers, Inc., screenings conditioned with lime were dewatered from about 90 per cent to 66 per cent moisture on a vacuum filter.

Acknowledgment.—The foregoing paper was presented Oct. 16 at the 35th Annual Convention of the American Society for Municipal Improvements.

Trencher Shovel Digs Sewer in Cramped Quarters

A construction job which afforded more than the ordinary amount of excitement was that recently executed by a crew of Ralph Bucci & Co., Pittsburgh sewer contractors, consisting of digging trench and setting pipe in a shallow, semi-round sewer tunnel under the plant of the Homestead Steel Works, Homestead, Pa. Steaming hot drainage water flows directly into the tunnel from the steel mill.

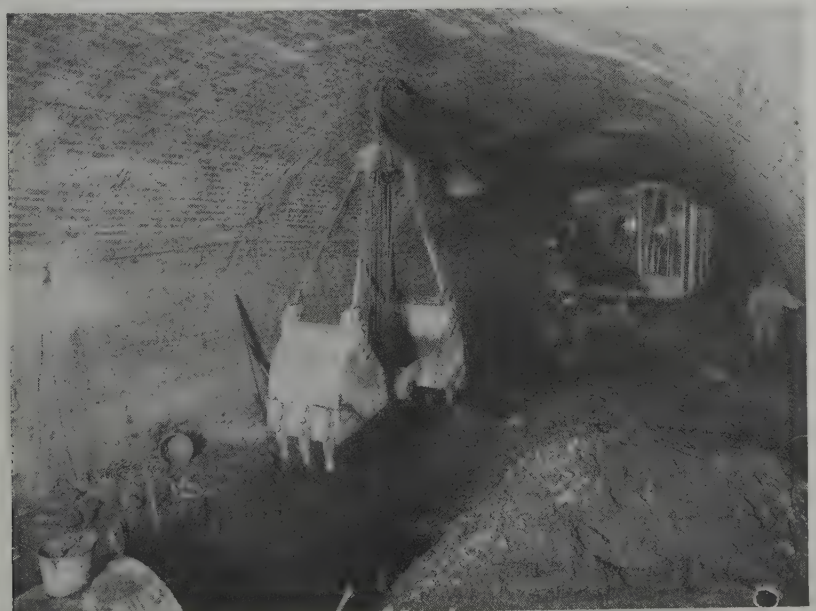
A sanitary sewer of 36-in. reinforced-concrete pipe was laid through the entire length of the 1,000-ft. tunnel. The trench for the pipe was dug to a depth of 4 ft. The contractors took the job after comparing the 13-ft. headroom in the tunnel with the clearance height of their Byers ½-yd. trencher shovel—11 ft. 2 in. It was found that the best way to handle the job was to use the trencher shovel boom, taking off the dipper and arm and substituting a ½-yd. clam-shell bucket. The bucket was replaced with a hairpin hook for pipe setting.



Laying 36-In. Reinforced-Concrete Pipe With Trencher Shovel Under Homestead Steel Works

Under the difficult conditions existing in the tunnel, the shovel was able to dig in excess of 300 cu. yd. a day, it is stated. However, only 80 lin. ft. of trench was excavated at a time; this length of trench was dug and the pipe set in 10 hours. Pipe laying was delayed because all joints in a section had to be sealed with tar and allowed to set before the next section was begun.

The possibility of an added thrill to the workers was introduced when it was learned that the water in the tunnel sometimes rises to a height of 6 ft. during heavy storms. Throughout the work, however, fair weather prevailed, and the members of the crew had nothing more than the normal flow to contend with.



Trenching With Limited Clearance Within Sewer Tunnel Under Steel Plant at Homestead, Pa.

Water Company Spends One Third of Every Revenue Dollar for Taxes

The total amount paid for salaries and wages last year by the Hackensack Water Company, serving fifty-one towns and cities in Bergen and North Hudson Counties, New Jersey, was $1,051,318.65, according to statistics prepared by the company's accounting department.

Taxes for the year amounted to $842,144.02. Of every dollar of revenue, 30½ ct. was paid out for taxes.

More than 50 per cent of the total revenue of the company is paid out in taxes and wages. Practically all of this amount, in addition to expenditures for materials, supplies, maintenance and repairs, is spent in the territory served by the company.

Coal used at New Milford and New Durham cost $100,103. To haul this coal, eleven freight trains of fifty cars each would be required. If placed end to end, the trains would reach over five miles.

The expense of repairing buildings was $22,604. Sufficient money was spent on postage to mail a letter to every man, woman and child in the city of Newark.

More than 1,000 different types and sizes of material are carried in the company's storerooms. During the year more than 3,500 purchase orders and 6,000 voucher checks were drawn. Cards in the company's files showing detailed costs of service installations number over 60,000.

Purchased Power for Pumping Station Operation

By T. R. HUGHES

Mechanical Engineer, American Water Works & Electric Co., New York, N. Y.

WITH the development in the last five years of central station power plants, generating electric energy at high efficiencies, and the increase in reliability of this power, due to the interconnection of the various transmission systems, the advantages of using purchased power for the operation of small pumping stations are becoming more significant. These advantages are being generally realized now. Operation with purchased power means a minimum of investment, a minimum of labor cost and a relatively high operating efficiency for small units. Compensating for these economies the cost of energy is usually somewhat higher than the cost of coal.

Comparison of Operating Costs.—To gain some picture of the size at which the steam plant no longer becomes the most economical for operation, I have plotted a curve in Fig. 1. This shows the total cost of pumping station operation, fuel, operating labor, maintenance and miscellaneous supplies, per water horse-power hour developed compared with the average water horse-power load on the plant. The term "water horse-power" is, of course, the brake horse-power required to drive a pump of 100 per cent efficiency. The cost of pumping per water horse-power hour is a particularly significant figure, both because it is a unit of work and because it may be readily visualized when it is considered that the overall efficiency of the average motor-driven pumping unit is in the neighborhood of 75 per cent. Therefore, one water horse-power hour may be roughly considered as equivalent to 1 kw. h.

The figures shown are all (except No. 14 which represents a carefully prepared estimate) taken from operating records of plants actually in operation and represent results being obtained. The only correction made to them was to reduce coal to $3.50 per ton. They are all fully comparable. The figures represent, with the exception of No. 13, plants operating reciprocating pumps, water being measured by plunger displacement. Actual water measured would be less and cost per water horse-power hour more than shown. With any centrifugal pump where water is metered economy will be correspondingly increased.

In Fig. 1 it will be seen that, with a plant as large as 650 water horse-power, the cost per water horse-power hour is ¾ ct. With a plant of 25 water horse-power average load, the cost of pumping is 4.8 ct. Both of the plants considered are operated more economically by purchased power. There are very few rates for energy at less than 1 ct. per kilowatt hour. To this must be added labor and miscellaneous operating costs. On the other hand with an average load of 25 water horse-power, it is probable that power could be purchased for about 1½ ct. Labor would be less than that required

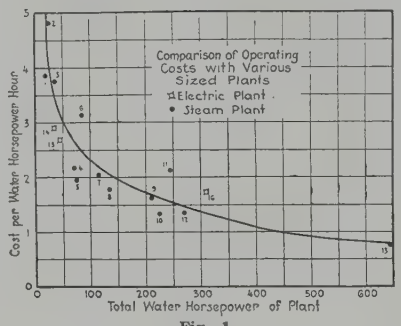


Fig. 1

to operate a steam plant, and it would appear probable that this station could be operated more economically with purchased power. From a point of view of operating cost along, it would seem probable that electricity would prove more economical on the plants smaller than 100 or 200 water horse-power.

Two points are also shown in Fig. 1 which represent the operating cost of plants operated on purchased power. The electric plant of 44 horse-power size, No. 15, is operating more cheaply than the steam plant of that size would. This means that not only is the cost of operation of this plant less than the cost of operation of a steam plant, but also considerable saving has been made in the investment required to build the plant. The 310 h. p. plant, No. 16, operated by purchased power, costs somewhat more to operate than one of equivalent size operated by steam. This, therefore, is approaching the point of demarcation between the economical electric and the economical steam plant.

Comparative Costs for Operation and Fixed Charges.—Figure 2 shows comparative costs for both operation and fixed charges of various types of plants. It is a study of a plant starting with a load of 535 and growing to one with a load of 890 water horse-power; that is, it would be a plant pumping an average of 15 m.g.d. against a head of 203 ft. and would grow to a plant of 25 m.g.d. against a head of 203 ft. In this study steam, Diesel engines and purchased power were all considered. The investment required under each of these heads was very carefully estimated and the operating costs are those which can be achieved. The coal is at $3.50 a ton as was the case in Fig. 1. Diesel engine fuel is at 6 ct. a gallon and electricity 1 ct. per kilowatt hour. Fixed charges on the investment required in each case were taken at 12 per cent for taxes, depreciation and interest. In the upper curve it will be seen that for the smaller plant purchased power is almost as cheap, considering operation and fixed charges, as the Diesel engine plant, even when the load is as great as 535 water horse-power. The lower curve showing operating cost shows that steam is considerably cheaper for each case. The investment in the small steam plant, however, is so large as to throw this out of line and makes the total cost greater than of either electricity or Diesel power. Purchased power is probably the cheapest for plants smaller than 400 h. p. Diesel engines may be the most economical source of power for plants with a load of from about 400 to 600 water horse-power.

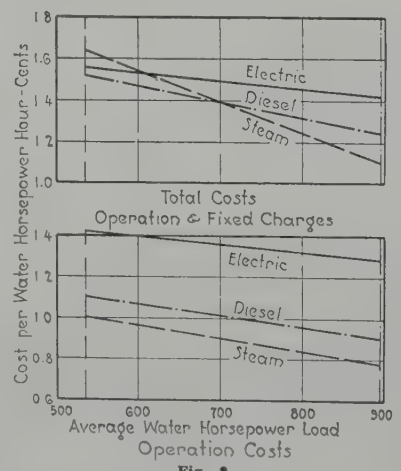


Fig. 2

When Fig. 2 was prepared, it was not realized that, in the case of the particular plant considered, the apparent dividing line between all three types of equipment would be covered. It was merely a coincidence that due to the loads chosen this was the case. The figures, unfortunately, all represent estimates. These curves and generalizations drawn from them are made, not with an idea of laying down any hard and fast rule, and saying to the water works designer that he can always save money, if building a plant whose average load will be 200 water horse-power, by operating it on purchased power, or that he will always save money by building a 400 water horse-power plant and operating it by Diesel engines. The curves can only be used to draw certain general conclusions and point the direction in which the most careful study should be made for plants of various sizes.

The plant studied in Fig. 2 was one which has a relatively high load factor. A plant which has a very low load factor would probably show greater relative economics due to purchased power than the one considered here due to saving banking losses and the like.

Where a plant pumps into a large reservoir with constant load and ample reserve, all the advantages are in favor of purchased energy. In the case of the very small plant with some storage in the system, automatic operation may be used and almost all labor eliminated. In some cases it may prove desirable partially to electrify the plant. Where some existing steam equipment is economical this may be the case, either using the steam for base load or for peaks as may best suit the conditions. The partial electrification of a plant has the double advantage of reducing the cost of duplication of electric power, should it be necessary, to a minimum and also holding a convenient club over the head of the power company to keep them from raising the rates after they think they have secured their customer, since it is always easy to go back to the steam plant if they prove unruly.

The most difficult condition under which purchased power may prove economical is the case of an existing steam operated plant of small size which is to be converted to an electric plant. The only excuse for the electrification is that the total cost of the electrified plant, both for operation and fixed charges on the equipment required for electrification, will be less than the cost of operation of the steam plant. It may be easy to show that the cost of operation of a plant run on purchased power is cheaper than one run on steam power. When, however, we have to pay fixed charges on new equipment out of this saving, it very rapidly evaporates. Although the power companies frequently point out the large savings which may be effected by the electrification, it is frequently difficult to justify this procedure when one must make considerable investment.

The maintaining of a high operating efficiency when the energy cost for the plant is high is important. If a plant is being operated on purchased power, it is highly important that care be taken in the selection of pumping units in order that the efficiency may be as high as possible during normal operation.

Operating Efficiencies.—One installation from which we have very good data on operating results shows that for 12 months the average operating efficiency of unit No. 1 in this plant was 66.7 per cent. Under test conditions and at exactly the right head this unit had an efficiency of slightly more than 70 per cent. It is a constant speed unit and the head varies as much as 10 per cent above and below the average which, of course, cuts into the operating efficiency. Unit No. 2 in this plant had an average efficiency of 72.7 per cent for 12 months with a test efficiency of about 77 per cent. Unit No. 2 is operated by a variable speed motor, and the efficiency, of course, is low at any time at which the motor is run below full speed. These two units pump into a system which has very little storage and, therefore, the pumpage rate has to follow the demand closely and the system is subject to wide variations in load. In spite of the exacting load conditions and with only two units installed, the pumps operated within 6 per cent of their original guarantees. The figures are based on average heads obtained and, therefore, are not absolutely correct.

In another plant at which four units are operated, the average efficiency of the four units on test is 64 per cent. The average operating efficiency for 12 months of these four units is 63.7 per cent. This is a direct system. The four units are relatively small, and all are constant speed units. They are operated close to their point of test efficiency at all times.

A third plant considerably larger than either of these two just spoken of, pumps into rather large reservoirs and the pumpage rate is practically constant from day to day. This plant is operated on purchased power, and the average operating efficiency for 12 months is 83.6 per cent. Tests on the two units operated, both of them variable speed units, give an average efficiency of 82 per cent. The efficiency of 83.6 per cent is hardly reasonable. The variable in measuring average operating efficiency and test efficiency is the head against which the units operate, which varies considerably. The only conclusion that can be drawn from these figures is that the operating efficiencies of these motor driven pumps, which deliver water into a reservoir at a very nearly constant rate, is very near the best test efficiencies of the units. Of the two units in this plant, one has a capacity of 14 and the other a 21 m.g.d. They, therefore, may operate very near to the designed conditions at all times as the one of the most suitable size may be operated all the time.

These last two cases cited illustrate the desirability, when installing several units at a station, of not getting two or three units of the same capacity. A little care in selecting the capacities of the units will result in being able to operate at full load at all times and with consequent high efficiency. When more than one unit is installed, with a change in load, one pump may be readily shut down and another started up and the most suitable unit always kept in operation.

With the interconnection of transmission systems, electric power is quite reliable, but some duplication is usually necessary. Judging by the experience we have had in two particular cases, it would seem probable that the duplication need be for use only for a short time. One plant supplied by a transmission line, 7 miles long, from the nearest sub-station, and that substation supplied by only one high voltage line, 25 or 30 miles long, has been subject to no extended outages. They have a number of times had power off for 15 minutes to an hour.

Another plant supplied by one transmission line, 1 mile long from the nearest sub-station, which does not supply any other consumers, and the substation supplied with power from a single high tension line, 15 to 20 miles long, has suffered from only occasional outages of from 15 to 20 minutes within the last two years. It would seem probable that, in supplying duplication for a plant operated on purchased power, unless the conditions were such as to make interferences likely, an outage of more than two hours would not be likely to occur.

Summary.—Summarizing:

1. We may say that a pumping station operated from purchased power will on operating cost alone be cheaper than with steam for plants whose load is from 100 to 200 water horse-power and below, the advantages of purchased power being greater as the plant becomes smaller.

2. When fixed charges as well as operating costs are considered, purchased power will probably be the cheapest plant to build and operate where the load does not exceed about 400 water horse-power.

3. For operation of a plant with purchased power, care should be taken to select units which will operate very near their peak efficiencies at all times. It is probable that for a direct system the average operating efficiency of the unit may be about 95 per cent of the guaranteed efficiencies provided suitable equipment is installed.

4. Purchased power with the present interconnection of electric systems is quite dependable and except for unusual conditions outages of more than 2 hours should not be expected.

Acknowledgment.—The above paper was presented before the New York Section of the American Water Works Association and is reprinted here from the October Journal of the Association.

Water Works and Sewerage in Wisconsin.—Figures in 1929 Waterworks, Sewerage and Refuse Code of the State Board of Health of Wisconsin show that 282 municipalities in that state have public water supplies and 211 have public sewerage. Of the latter 127 are not provided with any form of treatment. There are 10 municipalities in the state with less than 500 population (1920 census) that have both water works and sewerage and 29 that have water works only. Over one half the municipalities between 1,000 and 1,500 population have both water works and sewerage and about one quarter have water works only. All cities over 2,000 population except one are equipped with both water works and sewerage.

State Forbids 500 ft. San Gabriel Dam

Report of Consulting Board of Geologists and Engineers on Site for Los Angeles County, Calif., Flood Control Structure

As a result of a report by a consulting board of geologists and engineers, Edward Hyatt, State Engineer of California, has denied the application of the Los Angeles County Flood Control District for authority to construct the San Gabriel dam in the San Gabriel river, 30 miles northeast of Los Angeles, Calif. In the report of the state engineer the consulting board declared that the proposed San Gabriel dam, a gravity concrete structure, 500 ft. high and capable of storing 240,000 acre feet of water, could not be built safely on the foundation existing at "the forks" site. However, the board expresses the opinion that a dam of flexible type, such as an earth and rock fill structure of conservative proportions, could be built safely at "the forks" site.

Disapproval by the state of the application, according to the state engineer, is without prejudice to the right of the county to file any new application for a dam at this or any other site that the county may wish to submit. It means simply that the state finds that a 500-ft. concrete dam if built on the foundations at this location would not be safe and this particular application is disapproved.

The consulting board consisted of Charles P. Berkey, geologist, of Columbia University, New York; George D. Louderback, Geologist at the University of California, Berkeley; Ira A. Williams, Consulting Geologist, Portland, Ore.; G. A. Elliott, Engineer of the Spring Valley Water Co., San Francisco; M. C. Hinderlider, Colorado State Engineer, and J. L. Savage, Chief Designing Engineer of the U. S. Bureau of Reclamation.

The consulting board's report, follows in part:

Each Dam Site a Problem.—The natural conditions in the San Gabriel Mountains are much more complex than is usually appreciated. Although certain general geologic features prevail, each dam site is a problem in itself and demands special study and handling.

The rocks of this site and vicinity are ancient crystalline types, including granitic and dioritic gneisses and occasional schists, all cut by variety of igneous intrusions, including granite, aplite, diorite, dibase, basalt and porphyrites. The result is a crystalline complex, whose detailed history is long and involved, but whose character and quality would be eminently satisfactory for any engineering structure if the rocks had not undergone deformation and decay.

The rock complex is cut through in every direction by faults and slips and crush-zones that have separated the mass into blocks of varied size and shape, most of which are comparatively small and roughly wedge-shaped or lenticular. No portion of this site or immediate adjacent ground is free from this condition. In addition, each individual block formed by these fault movements is internally broken, and mol fractured and jointed, in such manner that most of the material separates readily into small pieces and there are no extensive bodies of solid rock.

Rock in Faulted and Crushed Condition.—The original structural make-up of the rock formation, with its many different types of varying individual resistance to crushing, has favored the development of internal differential movement, and this has resulted in the mashed and jammed appearance that characterizes the rocks of this site. The rock was not originally weak, but was unevenly resistant and the forces producing movement have been powerful enough to overcome the resistance of the whole mass.

It is generally conceded that the San Gabriel Mountain mass has been thrust up, and that in addition to very large movements on the faults along the boundaries of the mountain block, there are a few zones of major movement cutting through it. One of these zones takes an east-west course and has determined the alignment of the east and west branches of San Gabriel river. Another such zone apparently runs nearly north and south and has been followed by the river in its course below the forks. The forks is thus in the junction area of the two fault zones. The unusually numerous fractures at this locality seem to be consistent with this larger structural relation.

In addition to the faulted and crushed condition of the rock, much of it, especially that on the upper slopes of the canyon sides and along the principal movement planes and crush zones, is extensively disintegrated and decayed. The crushed and pulverized rock along the fault breaks is often transformed into clay gouge. Some of it is so soft that when moist it can be molded with the hand.

Unfavorable Controlling Factors.—The surface materials are weathered into soil. By the same process some of the unbroken material beneath is altered or rotted to such condition that it can be broken easily with the fingers. Along the more fractured zones decay extends as deep as explorations have gone. This altered condition, together with the excessively broken character of the ground and the smoothed and lubricated movement planes, are controlling factors with respect to any very large engineering structure.

Observation shows that the crush zones and movement planes and slips occur in all portions of the site, as well as beyond the site proper in every direction. Drilling data prove that the same kinds of weaknesses, especially the slips and faults and broken rock and gouge, extend also beneath the site to as deep as explorations have gone.

Landslides are common on the canyon slopes. These doubtless represent the slumping of individual blocks or groups of blocks, separated from each other by slip planes, when they are weakened by progressive undercutting of a stream, lubrication due to access of water and downward extent of weathering. Relatively recent slides have occurred at the site and at several places in the vicinity.

Where the rock is harder or more uniform than the average, the individual fault blocks are larger, the internal slips and crushes are less numerous and the accompanying decay correspondingly less extensive. This is the reason for the less broken appearance of the east abutment than that of the west abutment, although there are no different kinds of effects or any other principles represented.

Even the floor of the canyon is not free from this condition. A badly broken zone lies beneath the east third of the canyon bottom, where the bedrock channel is deepest. At this level the east portion of the rock floor of the canyon appears to be less substantial than the west, whereas higher in the canyon sides, the west wall is more broken than the east.

Because of the existence of the same conditions beyond the site, together with the less favorable topography both up and downstream, it is not possible to find materially better conditions at any other location in the immediate vicinity of the forks.

The character of the rock in the west wall of the canyon, where the proposed dam would rest upon and against it, is displayed in the abutment excavation. It is here shown to be broken through by an intricate system of fault planes with dips ranging from essentially vertical through intermediate angles to flat-lying and with strikes to nearly all points of the compass. Some of the fault lines may be traced across the excavation in a north-south direction and they thus parallel the canyon, while others appear to be correspondingly extensive in transverse directions.

Fault Planes.—Intersection of the fault planes and joints with which the rock is traversed has separated or split

the mass of the abutment rock into blocks of all sizes. Evidence of movement between contiguous blocks is the presence of a film or band of clay gouge, which when wet is smooth and slippery clay, and when dry, crumbly and gritty. There is often also a variable thickness of fault-breccia or shattered rock.

The fault planes are lines or surfaces of relatively ready percolation of water, by which alteration and softening of the adjacent rock has resulted. The inner parts of the larger blocks are usually comparatively hard and fresh rock; those of the smaller ones crumbly or in varying state of disintegration.

In excavation, separation takes place most readily along the slip surfaces between blocks. Where these are steep and approach parallelism with the canyon side, conditions are favorable to slumping of masses, such as the body of broken rock included in the recent "side" at the northerly side of the west abutment excavation.

No Suitable Foundation Rock Found.—The test shafts, tunnels and borings so far made give little hope that the conditions described above will materially improve with continued excavation. These explorations indicate that no suitable foundation rock for a high masonry dam is available under portions of the west abutment to distances of at least 190 ft. horizontally and 150 ft. vertically beyond the present excavation lines.

At the present time the face of the east abutment excavation has the appearance of being less broken and more substantial than the west side. In excavating into this wall the rock has separated, leaving a face determined by a set of well-defined smoothed surfaces, nearly parallel to the natural slope at this side.

This coincidence of position of a plane of separation with the average slope of the canyon side is to an extent deceptive, for it gives less favorable opportunity to see the actual physical condition of the abutment rock than at the west side. In the top portions of the excavation, however, the same intricate combination of faulting and crushing appears as in the west side. There is reason, therefore, to anticipate that greater depth of excavation may show a similar degree of instability at other levels in this abutment.

While the present excavations and exploration tunnels in the east abutment give promise of more satisfactory foundations than are available in the west abutment, neither the tunnels nor the borings on this side extend far enough to settle this point definitely. Furthermore, even the best rears of rock in this abutment are sufficiently intersected by planes of weakness and joints, some of which contain soft material, to throw doubt on its suitability for a dam of the height proposed.

The bedrock in the floor of the canyon, as shown by the drill cores and by the shafts now being put down, is of the same types of rocks as the canyon walls. In portions of many of the drill holes only a small percentage of core, or even no core, was recovered on account of the poor condition of the rock and both fault breccia and clay gouge are found in some of the cores.

The inference to be drawn from all available data is that the foundation rock in the canyon bottom is broken and is traversed by fault lines to an extent comparable to what is seen in the canyon side walls and abutment excavations. There is good reason to believe that strongly developed lines of break run lengthwise as well as across the canyon floor. Weathering and oxidization are not so general at this lower level, although these effects in certain places reach as deep as explorations have gone.

The fundamental requirement for a high concrete gravity dam is that it be built on firm, sound rock, of uniform compressibility. This condition does not exist at the San Gabriel site.

The Unanimous Opinion of the Board.—It is the unanimous opinion of this board that the foundation conditions are such that the dam proposed in application No. D-175 cannot be constructed without creating a menace to life and property.

While the primary purpose of this report as covered in the preceding pages is to advise on the safety of San Gabriel Dam, as proposed in the plans submitted by the Los Angeles County Flood Control District, the board in its investigations has come to the conclusion that the foundations and other conditions are suitable for a properly built flexible-type dam of conservative proportions. Such a type would not only conform to foundation conditions, but would also provide a structure which can best withstand earthquake shock or earth movement.

Flexible Type Dam Could be Built.—The board is of the opinion that a combination earth and rock fill dam, placed by the hydraulic method with concrete core wall, can be constructed safely at the site under consideration. The location of the reservoir site above a thickly settled and highly improved valley necessitates unusual precautions in the design of the dam, such as limited height, adequate cutoff, large freeboard, flat slopes and an ample downstream toe blanket. It calls for a spillway of generous capacity, designed for maximum floor occurrence. Unless conditions as now disclosed are found to be materially different upon further exploration, the board believes a safe dam of this type can be constructed at this site. Such a dam should be of width up and downstream to provide a percolation distance (length of water travel) along the base of the dam, equal to at least eight times the maximum depth of water against the dam. In addition to these conservative proportions, the dam should be provided with a reinforced concrete core wall, extending a proper distance into the bedrock at all points, in order to increase percolation resistance. Sluiced mat should also extend to bedrock in an open cut on the two sides of the core wall, the mat immediately up-stream from the concrete wall constituting the impervious core, the mat immediately below the core wall to consist of sand only. Such construction would prevent the travel of water in dangerous amounts either around or under the dam, and would provide a safe structure even though the concrete core wall were breached. The surface of the abutments above the crest of the dam should be brought to slopes that will prevent slides. Materials excavated to date from the abutments can be utilized in the earth-and-rock-fill type of dam suggested above.

Inspection of Valves and Fire Hydrants

At the Third Annual Conference of the Maryland Water and Sewerage Association Carl A. Heckmer of the Washington Suburban Sanitary District, Hyattsville, Md., gave the following suggestions as to what constituted a proper inspection of valves and fire hydrants:

Valves.—Semi-annual inspection advisable through Fire Underwriters' requirement is yearly inspection.

Covered valve boxes should be brought to grade.

All boxes cleaned of debris.

Set valve key on nut—pour kerosene or diluted crank case drawings down valve key—oil will run down the valve stem, lubricate it and revive packing.

Operate valve up and down, thereby cleaning groove of sediment and rust which is pushed out sides of groove.

Count number of turns—same for same make and size. This will bring to light bent valve stems or debris under gate without actually closing down main.

Grease gears on large valves—clean teeth of gears with wire brush.

Fire Hydrants.—Physical examination of hydrant first, condition of operating nut, nozzle threads, general appearance.

Turn on water with all caps on—listen with aquaphone for leaks in drain valve or hydrant barrel—note if all nozzle caps are tight in hydrant—measure static pressure by placing one cap on hydrant with pressure gauge attached.

Turn off water—remove nozzle cap and note rate of drainage.

Flush out hydrant noting residual pressure on one nozzle and rate of flow with pitot tube gauge.

Production and Collection of Sewage Gas

Its Advantages in Eliminating Nuisance Around the Disposal Plant and Performing Useful Work, with an Account of the Installation at Springfield, Mo.

By GEORGE S. RUSSELL

Russell & Axon, Consulting Engineers, St. Louis and Springfield, Mo.

THE gases given off from the sludge digestion chamber of either an Imhoff tank or a separate system of sludge digestion are various. The principal constituent, however, is methane, or marsh gas, which can be burned, and as a heat producer has a value between that of the artificial and natural gases used for domestic cousumption. This gas in itself has very little odor, but the other gases with which it is combined, such as sulphurated hydrogen, give rise to most of the obnoxious odors found around a disposal plant.

It can readily be seen then, that if some method of collecting and burning this gas can be devised, we are performing two services. First, we are eliminating one of the worst nuisances around the disposal plant, and second, we may use this waste product to perform useful work.

Some of the large plants in Germany are now collecting the waste gases given off from Imhoff tanks and utilizing them in various ways, either at the plant itself or by piping it into the local gas mains.

The Antigo, Wis., Installation.—One plant in the United States which has made use of this idea, and has been of interest to engineers generally, is the plant at Antigo, Wis. In this plant, which is of the separate sludge digestion type, the gas from the digester is collected and burned in a hot water heater. The hot water from this heater is carried through coils in the digester and serves to increase the temperature of the sludge. On account of the severe winters at Antigo, bacterial reduction is practically nil throughout a large portion of the year and some method of heating the sludge is necessary for satisfactory sludge digestion. Due to the results obtained at Antigo, the writer decided that what was practically a necessity at Antigo might still be made an economy in Missouri.

The optimum temperature for bacterial action, especially as pertaining to sewage reduction, according to various investigators, lies somewhere between 70° and 80° F., while at 40° F. the bacteria are practically inert. As the temperature of ordinary sanitary sewage varies in this latitude from about 40° or 45° in the winter to about 65° or 70° in the summer it is readily seen that this bacterial action is never at maximum efficiency and during the winter months we are getting very little if any reduction. This requires additional capacity for storage of sludge during the time that the bacteria are dormant.

It can be readily seen, then, that less sludge capacity will be required where some provision is made for heating the digestion chamber than under ordinary conditions and if this saving in capacity and consequent saving in construction cost is sufficient to justify the installation and operation of heating equipment, then the latter type will be the more economical. The amount of saving will depend on the range of temperature in the locality where the plant is being installed.

The Plant at Springfield, Mo.—The new plant at Springfield, Mo., is one of the separate sludge digestion type and has a contributory population of about 45,000 people. The writer made alternate designs for the digestion tanks in this plant. The one allowing for no heating had a designed capacity of 2 cu. ft. per capita and required two 50-ft. tanks averaging 21 ft. deep. The alternate design was for a single tank, 65 ft. in diameter and averaging 20 ft. deep, equipped with gas domes and heating coils. This tank has a capacity of 1½ cu. ft. per capita.

The price bid for the latter alternate fully equipped with coils, heater, pressure regulator, etc., was almost exactly the same as for the larger capacity and this alternate was built.

Results at Springfield Plant.—The writer had hoped to have a full report of definite data on this plant to present at this meeting, but due to the breaking of one of the pipes in the heating system, our records are incomplete at this time. We trust that we may give you more exact information in this connection later. However, the writer has sufficient information to feel justified in stating that even for the period from May 1 until the present time the increased efficiency will more than justify the 25 per cent reduction in capacity.

The present sewage flow in this plant ranges from 2½ m.g.d. to about 5 m.g.d. and the gas production from 22,500 to 27,000 cu. ft. We estimate that it will take from 10,000 to 15,000 cu. ft. for the digester. The city is installing hot water radiators in the plant for winter heating purposes, which last year took about two tons of coal per week and we still feel that there will be an excess of gas.

The use of heat in the digester has kept the sludge in excellent condition. In spite of the fact that for nearly a month, a new creamery emptied sufficient milk wastes into the sewer to make the sedimentation tanks look like they were filled with milk, the hydrogen ion content of the sludge has never shown an acid condition, falling as low as 7.0 but averaging between 7.2 and 7.3.

It is therefore self-evident even at the present time that this heating of the sludge gives better digestion and eliminates many of the troubles usually experienced in the operation of this portion of a disposal plant.

Results That May Be Expected.—It seems that the collection of gas from a sewage disposal plant and the utilizing of this gas for heating purposes may well be expected to accomplish the following results:

(1) Eliminate odors incident to Imhoff tanks or separate sludge digestion by the burning of waste gases.
(2) Decrease operating troubles due to maintenance of optimum conditions for sludge digestion.
(3) Decrease first cost by reducing the amount of sludge capacity required more than enough to offset cost of heating system. (This depends on range of temperatures at point of installation.)
(4) Decrease operation cost, due either to utilizing the waste gas for heating of buildings at the disposal plant or the sale of this gas for heating purposes.

Acknowledgment.—The above is a paper presented at the 5th annual Missouri Water and Sewerage Conference.

North Carolina Section Elects Officers.—The North Carolina section of the American Water Works Association at its convention last month at High Point, N. C., elected the following officers:

C. W. Smedberg, Superintendent of the water department of Greensboro, was elected president to succeed McKean Maffitt. T. C. Patterson of Mount Holly, was named vice president to succeed P. T. Dishner of High Point. Both H. G. Baity of Chapel Hill, and E. G. McConnell, of Charlotte, were re-elected secretary-treasurer and editor, respectively. The 1930 convention will be held at Hendersonville, N. C.

Weather As Affected By Electron Migrations

Why It May Be Possible to Forecast Weather Changes with Considerable Accuracy Far in Advance

By HALBERT P. GILLETTE

AT least in temperate latitudes there is an almost continuous flow of electricity from the earth, into the air. The source of this current has puzzled scientists. Perhaps the most commonly accepted theory is that of Bauer, who believes that the electrons come from the sun, and that they enter the earth in the polar regions, flow to lower latitudes and escape thence into the air.

It seems to me unnecessary to assume a solar origin of these electrons. All that need be assumed is that electrons circulate between two great magnetic fields in the earth, a lower field and an upper field, the latter being the well known Heaviside layer of electrons, 75 miles or more above the earth's surface. Electrons moving in orbits constitute an electromagnet, and since electrons in the air as well as in the earth rotate a full circle every 24 hours, with the earth, they constitute electromagnets. But, being free to move, these rotating electrons are repelled or attracted by other magnetic fields, such as the fields of sunspots and the fields of other rotating bodies like the sun, planets, etc.

Most of the sunspots rotate in opposite directions in the sun's two hemispheres, and therefore have opposite magnetic polarity. Hence when sunspots of a given polarity (N or S) predominate, their magnetic fields must tend to repel, the earth's rotating electrons having similar polarity. Due to the inclination of the earth's axis there must be an alternation of repulsion and attraction every six months, according as the earth's north or south pole points most directly toward the sun. This alone would cause important migrations of electrons in the earth and its atmosphere. There is also to be considered the inclination of the sun's axis, for the sun itself is a huge magnet. Finally, every one of the seven visible planets, not to mention several others not yet visible, must be counted upon to produce periodic migrations of the electrons in the earth and its air, depending upon the position of the magnetic axis of each planet relative to the earth.

So we have abundant means for producing a never ceasing flow of the earth's electrons, at times slow and at other times rapid. In short, electron currents must always exist in the earth and its atmosphere; and we need not assume that a single electron travels from the sun to the earth.

When sunspots are most numerous, obviously the migrations of electrons between the upper and lower magnetic fields of the earth will be very pronounced. This explains the fact that aurora are very frequent at or about the time of sunspot maxima. There is a great sunspot cycle of 11.2 years, and a similar cycle of auroral frequency exists. I have seen no mention of an intermediate auroral "peak," but I find that there is frequently one that is very pronounced, about half way between the 11.2-year "peaks." I find that these intermediate auroral "peaks" occur when Jupiter's north magnetic pole points most directly earthward, and that at such times there is usually a rainfall "peak" also. Douglass had previously noticed this intermediate rainfall peak, but had offered no explanation of it.

In this connection it may be well to point out that although the 11.2-year sunspot cycle is very regular, the corresponding rainfall cycle is less regular; for the earth is revolving around the sun at a mean distance of about 93,000,000 miles, and Jupiter is revolving at a distance five times as great and with an orbital velocity less than half that of the earth. In consequence of the changes in relative position of these two planets, there is a seeming lack of periodicity in the rainfall due to Jupiter's magnetic effect on the earth's electrons; but it is easy to calculate just when Jupiter's magnetic axis points most directly earthward; and I find that in every such case there has been a marked increase in rainfall in northern latitudes, provided that it was during the rainy season. This proviso merely means that Jupiter's magnetic field must be assisted by the fields of the earth and sun if much rainfall is to result.

The earth's axis is most inclined relative to the sun about June 21 and Dec. 21; and the sun's axis is most inclined relative to the earth about Mar. 8 and Sept. 8. Hence between Sept. 8 and Dec. 21, there occurs the maximum migration of electrons toward the north pole, and the converse between Mar. 8 and June 21.

In addition to the migration of electrons, there are two other important factors that affect the number of electrons in any region, namely, temperature and pressure. A rise of temperature releases electrons from atoms, and so does a fall of pressure. Hence in the summer and early autumn, electrons increase in number, which accounts largely for the thunder storms at that time. At high altitudes the electrons are more numerous than at low altitudes, which assists in explaining the increase in preciptation at high altitudes; for wherever electrons are numerous electron-whirls are most powerful, other things being equal, and electron-whirls impart a spirally ascending motion to the air.

Electron-whirls are caused by the action of the earth's magnetic field. This explains why cyclonic storms rotate in opposite directions in the earth's two hemispheres. I have little doubt that practically all air currents of meteorological impotance are created by electron-whirls. If so, weather is primarily an electrical phenomenon; and since electrical changes in the earth and its air are mainly the results of astronomical factors (sun, planets, etc.), it will become possible to forecast weather changes with considerable accuracy, far in advance. Eventually such forecasts will state approximately the inches of rainfall in each district during each rainy season. Indeed I shall not be surprsied if it becomes feasible to estimate the rainfall by months, with no slight degree of accuracy.

Ohio Filter Men Meet

The 9th annual Ohio Conference on Water Purification, was held Oct. 24 and 25, at the Fort Hayes hotel in Columbus. Of special interest were papers presented on the taste and odor problem and the sanitation of swimming pools. Visits were made to the Marble Cliff Quarries and to the new water softening plant at Marysville.

Officers for the ensuing year were elected as follows: O. F. Schoepfle, Sandusky, chairman; F. E. Sheehan, Portsmouth, vice chairman; J. M. Montgomery, Piqua, secretary-treasurer; Geo. M. Lieber, Fremont, and J. Sheldon Scott, Steubenville, members executive committee.

Fremont and Dayton invited the conference to hold its 1930 conference in those cities. Action with regard to the location for the next year's conference will be decided by the Executive Committee, which will be influenced by the choice of meeting place for the fourth Annual Sewage Treatment Conference. Its meeting place also is to be decided by its executive committee.

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Announcing Three New Editors

We take pleasure in announcing that three new associate editors, each an outstanding authority in his field, have been added to the staff of *Water Works and Sewerage*. Mr. John R. Baylis will have a section on Walter Filtration Plants; Mr. John R. Downes will have a section on Sewage Disposal Works and L. H. Enslow will write on Sanitation, particularly the application of chlorination in the water works and sewerage field.

Mr. Baylis is Physical Chemist, Division of Operation, Bureau of Engineering, Department of Public Works of Chicago. He is in charge of the experimental work on the filtration of the Lake Michigan water for Chicago, and in this capacity designed the Chicago Experimental Filtration Plant, which is the largest and most elaborate plant of its kind ever constructed. Previous to coming to Chicago in 1926 he was principal sanitary chemist, Montebello Filters, City Water Department, Baltimore, Md.

Mr. John R. Downes is Supervising Engineer of the Plainfield and Dunellen, N. J., Joint Sewerage Disposal Works. Mr. Downes has been active in the sewage disposal field for many years. He was in charge of the sewage disposal works of Plainfield, N. J., from 1913 to 1916, in the latter year becoming supervising engineer of the joint sewage disposal works. He was the first president of the New Jersey Sewage Works Association and he was largely responsible for the establishment of the New Jersey Experimental Station.

Mr. Linn H. Enslow is Research Engineer of The Chlorine Institute, Inc. Mr. Enslow in collaboration with Abel Wolman developed the excess chlorine or "residual chlorine" method of controlling chlorine dosage, which is now in universal use in the sanitary field. He formerly was superintendent of the filtration plant of Spartanburg, S. C., and later of the filtration plant at Gatun, Canal Zone. He has been research engineer of The Chlorine Institute since 1925.

These new editors were selected because of their particular fitness for the work they are to handle. Thus the readers of Water Works and Sewerage will be kept informed of the very latest developments and the best practice in the water purification, sewage disposal and chlorination fields.

Hoover's Great Construction Program for 1930

There has been a reduction in the construction of dwellings and industrial buildings (but not in public works) during the past six months. On the heels of this came the stock market slump. President Hoover and his great secretary of the treasury, Andrew Mellon, have announced that they do not regard the deflation of stock prices as an evidence of business weakness. On the contrary they attribute the decline in building to the high rates of interest brought about by abnormal stock market speculation and the flow of money into Wall Street.

Now that the stock speculation bubble has burst, Hoover has announced that he favors a great expansion of public works; and as the first great step in this program he proposes extensive river improvements and canalization that will ultimately result in reduced costs of transporting grain, coal, etc. He also favors enlarged programs of municipal, county and state construction of pavements, roads, water works, sewerage systems, etc. Without doubt the president's great prestige as an executive, engineer and political economist will cause his recommendation to be adopted. So there is assurance that 1930 will be the greatest year of public works construction in the history of America.

In addition to the impetus thus assured under the Hoover plan, it should be remembered that gasoline taxes are financing most of our road improvement programs. In California the monthly gasoline tax incomes are running 16 per cent ahead of those of a year ago. Most of the other states are also showing remarkable increases in gasoline sales, which means corresponding increases in funds available for road construction. Nor should the effect of increased production of automobiles and motor trucks be overlooked, not merely because of its effect on gasoline consumption but because of the increase in the number of voters who will insist upon having better pavements and wider and better roads. It is now certain that the total number of American motor cars and motor trucks produced in 1929 will be about 5,500,000. The old cars are not being scrapped at the rate that once was common, for cars are more durable and we are rapidly becoming a two-car-per-family nation.

As a result of President Hoover's business and economic conferences the greatest construction program in the history of the country has been developed for 1930. It is estimated that this will amount to over $10,000,000,000 and will include the following:

Roads and Streets	$2,200,000,000
Waterworks and Sewers	700,000,000
Steam Railway Construction	400,000,000
Federal Government Construction	750,000,000
Public Utilities	1,000,000,000
Building Construction	5,500,000,000
Total	$10,550,000,000

Nation's Purchasing Power Not Affected by Stock Deflation

In not a few recent articles it has been said that, aside from some reduction in the buying power of the "fleeced lambs," no industrial injury has occurred as a result of the drastic deflation of stock prices. A little thought shows that not even this reduction in buying can affect the total buying power of the nation.

To begin with the earnings of the stocks remain unaltered by their reduced market prices, and it is only their earnings that furnish buying power. The dividends may go to other owners, but this is merely a transfer of buying power. The annual surpluses remain with the companies, so the buying power that those surpluses represent does not change hands.

As to "paper profits" resulting from a rise in stock prices, they are not buying power until the stocks are sold and the profits are actually made available; but when that occurs, and money is transferred, by as much as the seller gains in cash with which to buy goods the seller loses in cash. So, in the final analysis, the total buying power of a nation is unaltered by any change in the prices of stocks, so long as no international trading is involved. International trading in stocks is trivial in comparison with national trading, so this factor need not be considered.

The well known and oft-repeated truth is that the vast majority of Wall St. transactions that involve stocks are gambling transactions. It is pure sophistry to argue that many of the stock buyers and sellers are investors, for active stocks are turned over so frequently that the nature of the transaction is clearly apparent. Most of us have a gambling instinct, so when public gambling on horse races and the like is barred by law, many of us turn to a sort of gambling that is not thus prohibited, and we call it speculating. We are far from implying that laws should be drawn to prohibit or even to curtail buying on margin. On the contrary, let freedom be unconfined, except, perhaps, that phase of it that enables pools to rig the market. Sooner or later men will learn that intrinsic values are not in the habit either of skyrocketing upward or of falling like the stick; and it is better that they learn to beware of such stock markets as we have witnessed in recent years than that they be forbidden to speculate.

In this connection it may be well to point out why many stocks had such a spectacular rise for several years following the close of the world war. Take, for example, public utility stocks. The editor, as a consulting engineer on public utility appraisals and rate cases, was employed by many public utility companies for several years following the war; and testified before commissions and courts as to the rise in wages, materials, taxes that made higher rates of charge necessary. Also it was shown that the values of utility plants had risen as a result of the rise in wages and in prices of machinery and materials; and fair percentages of profit on these higher values were likewise necessary under our constitution. As a result of such hearings, of which the ones in which the editor was engaged, were merely typical of hundreds, the rates of street car fares rose from 5 cents to an average of about 7 cents, and other similar, although usually smaller, increases were secured by utility companies in other fields. Prior to these increases in rates, utility common stocks had declined in price because of inadequate earnings. As increased rates went into effect, such stocks began to rise, and in many instances they increased several fold in price. Seeing such increases in stock values, accompanied by earnings that fully justified the increases, the public eventually came to think that there was no end to the gifts of the Santa Claus they called our American prosperity. So they began discounting anticipated increases in earnings of utilities and railways that were destined not to occur.

In the industrial field a general rise in earnings was also largely due to rise in prices of products, resulting from the inflation in currency that the war had caused. Here the effect was more spectacular than in the utility and railway fields, because it was more sudden. It was sudden because commissions and courts did not delay the rise in rates of charge. Competition usually could not check the rise, for a competitor had to buy lands and plant at prices that had advanced, and was thus forced to charge higher prices for his products, except in those rare instances where a complete offset to such increased costs could be secured through increased efficiency of machinery. Let the value of an industrial plant and lands double as a result of currency inflation, let that plant be mortgaged for half its original value, and let common stock at par equal the value of the other half. Then what happens is this: A plant capitalized at $1,000,000 (half bonds and half common stock) becomes worth $2,000,000, on which the bond holders have a lien of $500,000, leaving an equity of $1,500,000 that belongs to the holders of $500,000 par value of common stock, which now becomes worth $1,500,000, or triple par. As such a stock works up to such a triple value, speculators become inflamed by the sight of rising values. Many who buy secure enormous profits during the rise, and become imbued with the idea that they are Napoleons of finance. Not understanding the underlying cause of the rise, they attribute it entirely to American prosperity. They read that never before has our nation increased per capita productivity so rapidly (which is true, but not the cause of rising prices). They see no reason why this productivity should not continue to mount, so they infer that stock prices will continue to mount, and err because their premise is wrong. Increasing per capita productivity does not increase prices; it decreases them. The industrial companies who are able to show rising net earnings per dollar of invested capital are only those that excel the others in efficiency. These, however, are in the minority, but they are a spectacular minority; and the continued rise of the value of those stocks adds fuel to the speculative furnace—until, at last, the boiler explodes.

Almost any stock purchased seven or eight years ago, following the post-war panic, was a bargain. Such purchasers came to believe that they had shown wonderful business acumen, when, if the truth were known, very few of them had correctly analyzed the problem, if we may judge from the writings of financial advisers during the last eight years. Babson, just before the recent crash, issued a warning to sell, but it is apt to be forgotten that he issued a similar one in 1921 at the very time that he should have been advising the purchase of stocks. And up to the very moment of the recent debacle, the great majority of the professional prophets in the realm of speculation were as optimistic as such prophets usually are.

During the editor's investigation of public utility rates, he analyzed the rates of return on the market values of all classes of American securities for many years back. Some of the conclusions thus derived were published in "Engineering and Contracting" and "The Analyst." The relation between the risk factor and the earnings of bonds and stocks was deduced; and the average "market price of money" was derived. Just before the recent bursting of the stock bubble of 1929, many stocks were selling at more than double the price warranted by the risk factor and the earnings. It was evident from such facts that "frenzied finance" was due for a fall. Many a banker had come to that conclusion. Our Federal Reserve System had issued repeated warnings. But it is the characteristic of nearly every one of us to be oblivious to such warnings, especially when we have ignored them and profited by ignoring them for a year or more. More than two years ago the warnings began to come from conservative bankers, but investors listened to market tipsters instead, and the headache of the day after is now theirs. We are deeply sorry for them. We have ourselves experienced, many years ago, their every feeling. Out of that bitter experience came the resolution never to buy stocks on tips, but to study methods of correctly appraising the intrinsic values of securities. You will be told that no values are intrinsic. This is quibbling over a definition. Certainly there are stock prices that exceed the present worth of prospective earnings, just as there are others that are below that worth. The successful investor, as distinguished from the speculator, first learns to appraise intrinsic values, and then backs his own judgment and not that of some tipster who sells or gives him advice but risks no money of his own.

Why Rock-Fill Dams Are Best Over "Dead Faults"

In several recent reports on dam sites in California, geologists and engineers have used the expression "dead faults," and "crustal stresses long ago adjusted." It is our opinion that there is no such thing as a "dead fault," if by that is meant a crustal crack along which no further movement will ever occur. To begin with it is little more than a guess to say that no recent movement along a fault has occurred, if by recent is meant within a century. And as for saying that no future movement will occur, obviously that is the wildest of conjectures. There are many instances of volcanoes that had been "dead" for generations, yet suddenly became alive. What, then, is the criterion of "death"? Only long inactivity, but "long" is an indefinite and purely relative term. At best the only sound inference that can be drawn from long inactivity is that the volcano is dormant. When it will awake, no one knows, but that it will awake some time is probable. The same is true of crustal movements along faults.

The editor has published evidence that indicates clearly the cyclic nature of volcanic and earthquake phenomena, as well as those great crustal movements that have elevated or depressed large continental areas. More evidence of the same sort will soon be published. Since application of the mathematical rules of probabilities to these data very strongly support the cyclic theory of crustal movements, both great and small, it is no longer logical to speak of any fault as being dead.

This being granted, it follows that no rigid dam should be built over a fault in any region where crustal movements are prevalent. The St. Francis dam is a case in point. It straddled a "dead fault" that suddenly came to life. See "Engineering and Contracting" (April, 1928) for the measurements that showed that a crustal movement took place after the dam was finished, and probably compassed its destruction.

The San Gabriel (Calif.) dam site is under investigation by several geologists and engineers. Already there is disagreement among the doctors, some alleging that the fault at that place is "dead," others, that it shows signs of recent slippage. It is not very material whether recent slippage has occurred or not. That slippage will occur some day is probable, for the region is one of repeated, although slight, crustal movements; none of which would injure ordinary structures, but any of which might destroy a rigid dam.

In a previous editorial article we advocated the use of a "rock-filled dam" for this site. After the writing of that article, but before its publication, E. C. Eaton, Los Angeles County flood control engineer, reported to the Board of Supervisors that it might be wise to substitute a rock-fill design for the concrete, at least on the west abutment. He recommended a careful study of the 250-ft. rock-fill dam at Bowman, near Fresno, Calif. He suggested that the eastern part of the dam be made of concrete as originally designed. It is our opinion that it would be wiser, and probably cheaper, to make the entire dam a rock-fill structure about 250 ft. high. It would then be flexible throughout, and unquestionably safe.

No rock fault should be regarded as being unquestionably dead. Hence dams over faults should be either earth or rock-fill or a combination of both, well sheeted on the upstream face.

Since the foregoing was written, New England has experienced the most severe earthquake shock in 174 years. Incidentally, crustal movement along the Dundian fault, near the Bay of Funday, is believed to have severed nearly half of the score of cables that cross the Atlantic Ocean from that region. The first Atlantic cable was laid in 1858, more than 70 years ago, and this is, we believe, the first instance of cable breakage due to a crustal movement. Had geologists been previously consulted as to the risk of such an accident near the Dundian fault, it is likely that there would have been a difference of opinion, with the majority inclined to call it a "dead fault." In some respects geology is almost an exact science. In most respects it is still embryonic and very inexact. Of this the editor is convinced both by his college training, as a mining engineer and by his recent studies of crustal movements and the geological literature on the subject.

H. P. Gillette

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Badger Meter Mfg. Co. Has Biggest Year—Holds Its Annual Sales Meeting

THE accomplishments of the company during 1928 were the key notes of the annual sales meeting of the Badger Meter Mfg. Company, which was recently held in its home office at Milwaukee, Wis. The officials of the company pointed out the strides made during the past year, and also stated that 1928 was the biggest year in the history of the company, which is now in its 26th year. This was duly credited to increased manufacturing space and facilities, additional sales representatives, and a more complete line of water meters.

During the year 1928, the company made an addition to the plant which covered a half block square, giving it an increased floor space of 45,000 sq. ft. in the manufacturing and assembling buildings. Besides this addition a new brass foundry was constructed, having 15,000 sq. ft. of floor space and equipped in the newest and latest type of machines, which makes this foundry one of the most outstanding of its kind in the field.

What News

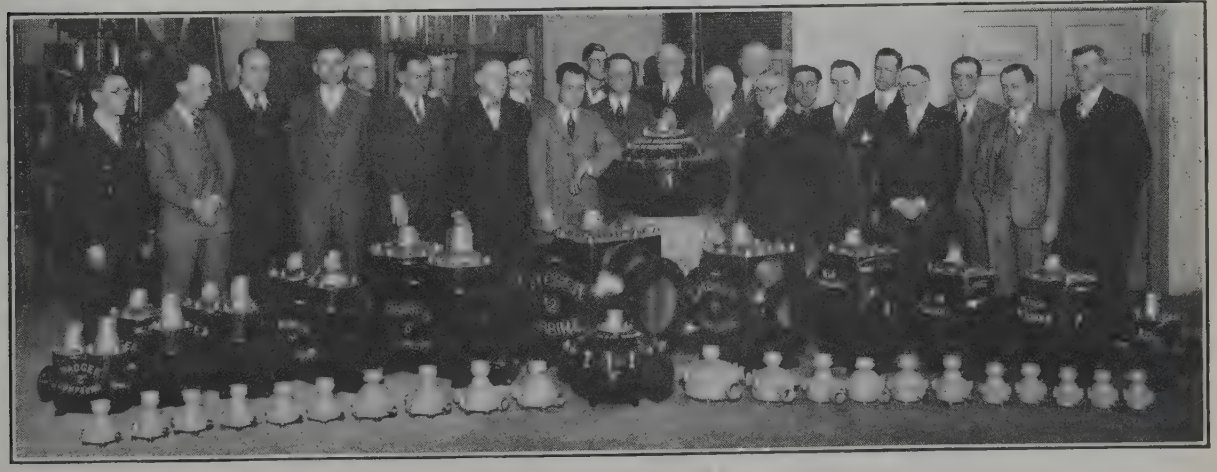
Coming first by runner, and horse and rider, then stage-coach, steam-car, telegram, cable, down to the days of wireless and airplane, from North—East—West—South, NEWS has been eagerly watched for by a waiting world. The little world watching for the NEWS we have to give is just as eager to know of the happenings in the engineering field—how the output of the manufacturer is increasing and how the distributor is handling it. And, to be a worthy distributor of this information it must come to us from all four quarters — North — East — West — South,—how else could it be NEWS.

Wherever you are, let us tell your news to our engineering world. Anything that is of interest to the growth and welfare of your business, is of interest to us. Send your stories and pictures to The Editor, Distributor News, Gillette Publishing Co., 221 East 20th Street, Chicago.

During the past year some new models were added in order to give Badger Meter a complete line, which new line includes a size and type for all service, from the little ⅝ in. disc meter to the large 12-in. turbine. In accomplishing this the company redesigned its line of compound meters, which now range in sizes from 2 in. to 8 in., complying fully in detail with the American Water Works Association and the New England Water Works Association's standards with reference to laying lengths, likewise establishing capacities averaging 25 per cent greater than standard specifications demand. In addition to this, it reduces the net weight of all sizes of this type of meter on an average of 50 per cent through special cast-iron processes developed, this because of greater tensile strength. Naturally, it makes for increased ease of handling on installations and maintenance. Many developments of a material nature were reported in the Badger turbine meters, which range in sizes from 2 in. to 12 in. All changes were made to increase efficiency and serviceability.

Further refinements were included in the disc meters, which range in sizes from ⅝ in. to 6 in., also in the split case type. This centers itself around the standard oil-enclosed gear trains.

The officers of the company reported that the company's engineering staff and research laboratory staff have been added to considerably and have mapped out a definite program of activities which will keep Badger meters abreast of the demands of the field and will introduce such new meters as are necessary from time to time to increase



Representatives of Badger Meter Company, Reading from Left to Right:

1. G. U. Pritchard, Cincinnati, Dist. Mgr.
2. Chas. Reisch, Cincinnati.
3. S. L. D. McClintock, Mattoon, Ill.
4. J. G. Hollowell, Savannah, Ga.
5. B. G. Dow, Elmira, New York.
6. J. C. Miller, Milwaukee, Research Eng.
7. Luke L. Ballard, Gen. Sales Mgr., Milwaukee.
8. E. Krueger, Chief Eng., Milwaukee.
9. H. Buchholz, Asst. Secy.-Treas, Milwaukee.
10. C. W. Wright, Pres., Milwaukee.
11. N. H. Abrams, Waco, Texas.
12. W. J. Zimmers, Director, Milwaukee.
13. J. J. Mueller, Director, Milwaukee.
14. R. M. Stotler, Western Sales Mgr., Kansas City.
15. D. F. Noonan, Eastern Sales Mgr., New York City.
16. J. L. Sinyard, Vice-Pres., Milwaukee.
17. P. Quartana, Time and Cost Dept., Milwaukee.
18. Frank Ketcham, Factory Supt.
19. M. L. Medlenka, Kansas City, Mo.
20. W. L. King, Dist. Mgr., Los Angeles.
21. V. C. Perkins, Chicago.
22. E. L. Holzhaueser, Wisconsin.
23. A. C. Hollowell, Charlotte, N. C.

meter efficiency. During the past year the company has successfully developed an automatic batch water meter for accurately measuring water on central concrete mixing plants, also a companion concrete batch mix meter for installation on portable concrete mixers.

During the past year the company's industrial meter division has been expanded and now represents a much greater variety in fluid measuring developments, covering hot water, oil, grease, gasoline, brine and acid meters. An electric alarm register set-up for practical application for measuring equipment as applied to water softeners was also developed.

The company's sales conference was concluded with a banquet at the Milwaukee Athletic Club on the last evening of the meeting. Twenty-five of the company's sales representatives, in addition to district managers and other members of the personnel, attended the meeting. The sales representatives came from all parts of the country, but the attendance was much affected by the influenza epidemic which swept the country at the time this meeting was held.

Modern Plumbing in Land of King Zog

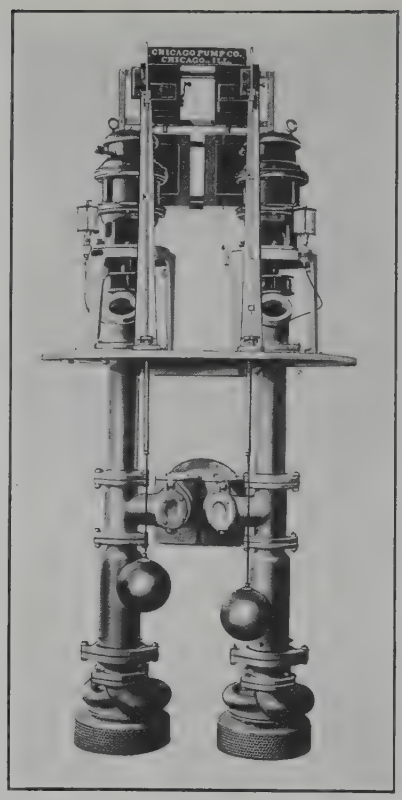
This is a story of Tirana, the home of King Zog of Albania, and it seems as if it ought to begin "Once upon a time," but if it did it would be a fairy story, and this is a true story and the time is NOW 1929.

Tirana is located just northwest of Greece, and King Zog is the newest ruler in Europe, and being a modern king, he wanted some modern improvements, so last month Tirana was supplied with electric lights for the first time in its history.

In spite of the new and modern king and the new and modern electric lights, Tirana is still something of a fairy story appearing town, for the streets are unpaved and there are no sidewalks. On both sides of the narrow main thoroughfare oriental bazaars display their wares—merchandise of all kinds.

There are no "Stop and Go" signals in this town and donkeys laden with wares and women carrying bottles of water on their heads jostle one another in the streets, and to the stronger belongs the right-of-way.

Here then in this town with the fairy-story sounding name and its medieval setting has appeared one of the very latest types of sewage ejectors known to civilization. As soon as the power necessary for operation was available this modern plumbing installation was selected by the American Legation at Tirana.



"Flush-Kleen" product of Chicago Pump Company, chosen by American Legation for installation at Tirana, Albania

Because of the scarcity of mechanics who are familiar with this type of equipment and because repair parts, if needed, would be hard to get, the engineers working for the American Legation gave heed to these matters, and for this reason the manufacturers of the "Flush-Kleen" Sewage Ejectors are pleased that this type of equipment was chosen for the work.

So the "Flush-Kleen" Ejectors have gone to work in the land of King Zog, and it probably won't be long now before the natives and the modern king take up the cry of "Bigger and Better Tirana", and Tirana storekeepers will have to move to other quarters to make way for the steam roller.

Promotions

The Lincoln Electric Company, Cleveland, Ohio, announces that Mr. J. E. Durstine has been advanced to district sales representative for the Southeast, with headquarters at Birmingham, Alabama. Mr. H. P. Egan has been made district sales representative for central Ohio. He will be located at Columbus.

The Lincoln Electric Company are manufacturers of Stable-Arc Welders and Linc-Weld Motors.

To Develop Water Systems on Guaranteed Basis

The Fairbanks-Morse Water Supply Co., Chicago, Ill., has been organized recently to handle the complete development of water supplies on a basis of guaranteed quality, quantity and cost. The parent organization, Fairbanks, Morse & Co., has, of course, been a builder of pumps for many years and has during that time supplied pumps for many of the large municipal and industrial plants of the country. The new subsidiary organization, however, approaches the water supply from an entirely different angle.

After a thorough geological survey and hydraulic investigation of a plant's water supply has shown favorable possibilities, the Fairbanks-Morse Water Supply Co. agrees to deliver a definite quantity and quality of water at a definite price per 1,000 gal. The plan is worked out so that the municipality is not required to invest any money in the pumping plant. Water may be purchased at a fixed price for a period of years, at the end of which time complete title to the plant passes to the city. At any time during the period the municipality has the option of taking over the plant.

Several installations of this character are now being developed. One of these is that of the City of Havre, Mont., where a supply of 3,000,000 gal. a day was guaranteed at an investment cost of $72,000. Three plants are being developed for the city of Brooklyn, N. Y., which will be used for furnishing water for sluicing ashes at incinerator plants. At Muskegon Heights, Mich., another guaranteed supply is being developed.

The Fairbanks-Morse Water Supply Co. is headed by P. D. Bowler as vice-president and general manager. Mr. Bowler was one of the founders of Layne & Bowler Corp. and was president and general manager of that organization for many years.

P. D. Bowler

The Hooker Chemical Plant at Tacoma Begins Operations

THE Hooker Electrochemical Co. of Tacoma, Wash., and Niagara Falls, N. Y., has just completed and put into operation its plant at Tacoma Tide Flats, construction of which was started last August. This is a record in construction of this type. The cut taken from a drawing of McKim, Mead and White, architects, shows the building to be of a permanent character and pleasing in appearance. The site comprises about twenty acres, located on Alexander Avenue near Hylebos Waterway. In choosing this site the officers of the company secured convenient shipping facilities, satisfactory power supply and rates, without excessive land values. These features allow a central distributing point for liquid chlorine and a convenient foreign outlet for caustic soda.

Tacoma Plant of Hooker Electrochemical Company from drawing by McKim, Mead & White, Architects

The twenty-five years of experience gained by the Hooker Company in their Niagara Falls plant, which was started on a small scale and is now one of the largest chlorine producers in the country, has enabled them to open the Tacoma plant on a large scale. With the exception of a few skilled executives transferred from the eastern plant, the personnel of the western organization is made up of western men.

The patents covering the Townsend Cell (the process of manufacture whereby electric current is passed through a brine solution made from common salt, thus securing the elements sodium and chlorine), are owned by the company. This process is economical in power consumption and requires a minimum floor space per ton of output, in that Townsend Cells can be efficiently run at over 5,000 amperes. About twenty different chlorine products are now being manufactured at the Niagara Falls Plant, and these products will be duplicated in the west as the demand arises.

Elon H. Hooker, President of Hooker Electrochemical Company

The two main raw materials for this plant are power and salt. The power is supplied under a contract with the Department of Public Utilities of the City of Tacoma, and the salt is secured in New York, Louisiana, California and from Spain, Italy and China. Handling facilities permit of it being unloaded at a rate of 1,000 tons a day, and it is stored in steel tanks to provide for full capacity operation for many months.

The general supervision of the sales work of the company is in the hands of Mr. M. H. Hooker, one of the three vice-presidents, while Mr. A. H. Hooker, Jr., is sales manager for the Tacoma plant. Mr. Hooker, Jr., has his headquarters in Tacoma and is available at all times for consultation on sales service problems.

The general administrative offices of the company are located at 25 Pine Street, New York City, in a building owned by the company, and in this building Mr. Elon H. Hooker, president of the company, has his offices. Mr. Willard Hooker and Mr. E. R. Bartlett serve the company as vice-presidents, and Mr. Bartlett also occupies the position of works manager for the plants at Tacoma and Niagara Falls. Mr. R. L. Murray is superintendent of the plant at Niagara Falls, and Mr. J. A. Flynn fills this office for the Tacoma organization. The other officers are Mr. J. M. Rowland, chief engineer; Mr. A. M. Hooker, technical director, and Mr. L. A. Ward, secretary.

The present capitalization of the company is $2,700,000 6 per cent cumulative preferred stock, par value $100.00, and $2,500,000 common stock, $100.00 par value, paying 6 per cent annual dividends. The bonded indebtedness is approximately $3,500,000, of which $1,500,000 6 per cent service B bonds were recently sold. It is believed that the investment in the Tacoma plant is something in excess of $1,500,000.

Follow Through

The Insley Manufacturing Company, engineers and manufacturers of Indianapolis, Indiana, and a division of the National Equipment Corporation, has issued in booklet form, for the use of their salesmen, all trade paper advertising to be used by them during the first six months of the year. Because it seems such a practical thing to do, we quote the statement which appears on the cover:

"Good advertising is nothing more or less than the assembly in printed form of the sales experience of an organization and the selling points proven to be most effective, to the end that the work of the salesmen in selling the customer is made easier, and the efficiency of the salesman is therefore increased.

"We want our salesmen to know our advertising, and to use it effectively. Each Insley advertisement has, or should have, a separate basic idea or sales appeal, which either advances our products in the esteem of the prospect or meets resistance that may be in his mind. The salesman should know these points, watch for new ones and incorporate them in his sales presentation.

"With this idea in mind we have had proofs of our Trade Paper Advertising for the first six months of 1929 made in booklet form, and request that you put it in your Insley Sales Manual, and refer to it occasionally. We hope it will help you yourself develop new ideas, and that it will help you put these ideas across with your customers. If it does this, it is good advertising."

All distributors will see the logic and good sense in the Insley Manufacturing Company, asking their salesmen to study their national advertising, and the same reasons which make it advantageous to these salesmen, will make it equally valuable for distributors to study the advertising of all the lines which they represent. Insley has presented this method to their men in a very compact and convenient form, but distributors could make their own booklets, containing, just as the one described, all advertising presenting their lines for from three to six months, as the advertisements appear, and study them. Take advantage of the national advertising which the manufacturers give you, and follow through.

Uniform Name Adopted for International Cement Companies

According to a statement issued by Mr. H. Struckmann, president of the International Cement Corporation, all subsidiaries of this corporation in the United States, as well as the Cuban Portland Cement Corporation, Argentine Portland Cement Company and the Uruguay Portland Cement Company, will be known as the Lone Star Cement Company. This change in no way affects the management, policies or products, but is one in name only.

The name, now universally adopted, had its origin about 30 years ago in the "Lone Star State," when a small mill in Texas began to produce Lone Star Cement, and which was to grow into a chain of 13 mills with an annual capacity of 20,000,000 barrels, under the direction of the International Cement Corporation, formed in 1919, when the annual capacity was 2,900,000 barrels.

While each Lone Star Cement Company is an independent organization, the resources of the International Corporation are available for scientific research and support in all modern practices. "Incor," a perfected high-early-strength Portland Cement is one of the achievements of the International System. This product was used in the construction of the Moffat Tunnel, and also in the Arlington Memorial Bridge, over the Potomac River from Washington, D. C., to Virginia, now under construction.

The mills of the Lone Star Companies are located in Alabama, Indiana, Kansas, Missouri, Louisiana, Pennsylvania, Texas, New York and Virginia, as well as the foreign countries previously mentioned. Cooperation between these companies enables them to render rapid, dependable service.

Road Show Queen Rides a Caterpillar

Miss Lily Damita, starring with Ronald Colman in The Rescue and The Bridge at San Luis Rey, who was acclaimed Queen of the Road Show at Cleveland, during her personal appearance in that city. "Good Roads lead to Good Movies," said Miss Damita, "and both are great educators and instruments of peace and understanding." This is the first "Caterpillar" Ten of the line and already famous as the most traveled and viewed tractor in the world. It has traveled over 10,000 miles and has been seen by over 1,000,000 people. Gov. C. C. Young's daughter unveiled it at California State Fair. "Jimmy" Walker unveiled it at Eastern States Exposition.

Gorman Joins Wallace & Tiernan

Arthur E. Gorman, well known sanitary engineer, has joined the staff of Wallace & Tiernan, and will be located at the headquarters of this company in Newark, N. J., on sales promotion work. Mr. Gorman has served the Department of Public Works of the city of Chicago as chief sanitary engineer, and more recently as public health engineer for the Sanitary District of Chicago.

He entered the service of the city of Chicago in January, 1924, following the water-borne typhoid fever outbreak on the South Side in the fall of 1923, prior to which time he served for six and a half years with the United States Public Health Service as an assistant and associate sanitary engineer. A very effective system for supervision and control over the chlorination of Chicago's water supply was installed under his direction.

The American Water Works Association, in June, 1927, awarded to him the John M. Diven Memorial Medal, as the member "who has best served the Association during the year." For two and a half years he served the American Public Health Association as secretary, and last year was made chairman of the Public Health Engineering Section of this association. When the American Water Works Association met in Chicago in 1927 he was secretary of the Chicago Local Committee, and last fall at the Fifty-seventh Annual Meeting of the American Public Health Association in Chicago, he served as Convention Manager.

Mr. Gorman has a wide acquaintance in the waterworks and public health profession and has the best wishes of his friends in his new undertaking.

Cutler-Hammer, Inc.

According to a recent announcement the Cutler-Hammer Manufacturing Company of Milwaukee, Wisconsin, has become Cutler-Hammer, Inc. The new company is organized as a Delaware corporation with the following officers: Chairman of the Board, R. F. Bacon; President, B. L. Worder; Vice-president, F. L. Pierce; Vice-president, J. C. Wilson; Treasurer, H. F. Vogt; Secretary, W. C. Stevens.

The Board of Directors announced are: F. R. Bacon, Milwaukee, Wis.; F. L. Pierce, Milwaukee, Wis.; B. L. Worden, West Orange, N. J.; Carl A. Johnson, Madison, Wis.; T. Johnson Ward, New York, and L. A. Lecher, Milwaukee.

In the change from a Wisconsin to a Delaware corporation the Cutler-Hammer Mfg. Co., of Milwaukee, the Cream City Foundry Co., of Milwaukee and Cutler-Hammer Manufacturing Co., of New York, are united under one name. They are identified with the manufacture of electric motor control, wiring devices and allied lines.

Timken Steel & Tube Co. Plans $1,000,000 Expenditure

A 200-acre tract of land, extending 2 miles west of this company's present holdings, has been purchased to put into effect during the coming year an expansion program which will amount to about $1,000,000. Room will be provided for future expansion, according to information received from the Timken Roller Bearing Company, of Canton, Ohio.

A tube mill, the first unit of this work, is now under way. This calls for a building 320 feet wide by 420 feet long, which will represent for building and equipment a cost of about half a million dollars. It is expected that this mill will be ready for operation by April 1st.

Palouse Tractor and Equipment Co. Takes Western Territory

According to newspaper story, the subdivision of the territory formerly served by the Hofius-Ferris Company in the far west, a new company has been organized to take over Whitman County, Washington, and Clearwater and Latah counties in Idaho, as tractor and equipment distributing headquarters. The new company will incorporate for $50,000 and operate under the name of The Palouse Tractor and Equipment Company.

H. W. Fairweather and L. J. Acuff, former residents of Spokane, become managers of the new company and will reside in Pullman, Washington. They were formerly interested in the Hofius-Ferris Company. Mr. L. C. Thomas, who had been serving as manager of the Pullman branch of Hofius-Ferris, will also be connected with the new organization.

Hercules Motors Declares Dividend

The year 1928 paid a total dividend of $5.00 to the stockholders of the Hercules Motors Corporation of Canton, Ohio, according to a report of a meeting of the directors held the last of December. A $2.50 dividend was declared July 1st, and the same amount January 2, 1929.

Business for the past year was reported as slightly in excess of 50 per cent over the previous year, and profits increased accordingly. Orders on the company's books for delivery during 1929 are already in excess of the total number of units shipped during 1928, and the increase of 1929 over the business of 1928 promises to be a large one, judging from present reports.

The following directors and officers were elected: H. H. Timken, Chairman of the Board; E. A. Langenbach, president; Chas. Balough, vice-president and general manager and H. P. Blake, Secretary. H. H. Timken, E. A. Langenbach, R. W. Gallagher, Gordon Mather and Chas. Balough will succeed themselves as directors.

H. Burdett Cleveland Announces New Member of Staff

Mr. Arthur L. Reeder, a member of the Society of Civil Engineers, and of the American Water Works Association has recently joined the staff of H. Burdett Cleveland, Consulting Sanitary Engineer, as Principal Assistant Engineer.

Mr. Reeder's experience in water purification and sewage disposal and construction, has been extensive. Over a long period of time he was connected with the Philadelphia Filtration Bureau, the Baltimore City Water Department and with the Pennsylvania State Department of Health. His most recent work has been in connection with installations at Reading, Pa., and Youngstown and Niles, Ohio.

The offices of these consultants are located at 225 Broadway, New York City.

Prest-O-Lite Establishes New Plant at Memphis

A new Prest-O-Lite Acetylene Plant, at 1241 North McLean Boulevard, Memphis, Tenn., commenced operations December 19, 1928. This plant, which is the thirty-sixth of the Prest-O-Lite chain, will supply nearby industries with dissolved acetylene for oxy-acetylene welding and cutting.

J. Brown is superintendent of the Memphis plant and C. A. Anderson, whose headquarters are at Birmingham, is district superintendent.

A. J. Sweet Joins Westinghouse

Mr. Arthur J. Sweet, formerly in consulting practice in Milwaukee, has joined the Commercial Engineering Department of the Westinghouse Lamp Company. Since 1910, when associated with the Holophane Company, Mr. Sweet has made extensive studies of street lighting problems.

In 1913 Mr. Sweet went to Milwaukee to become a member of the firm of Vaughn, Meyer & Sweet, and while serving in this capacity the City of Milwaukee adopted the recommendations of his firm for a complete new street lighting system. After severing his connection with this firm he entered into independent practice, which he continued until joining the Westinghouse organization.

Monarch Tractors Corporation Becomes Division of Allis-Chalmers Mfg. Co.

An announcement from the Allis-Chalmers Manufacturing Company, Milwaukee, states that the Monarch Tractors Corporation is to be taken over and operated as the Monarch Tractors Division, Springfield Works of Allis-Chalmers Manufacturing Company, effective January 1st, 1929.

The Springfield, Illinois, works will continue the manufacture and distribution of the Monarch Tractors, but will have the advantage of the larger organization and increased facilities gained through the new arrangement.

Change of Address

Announcement is made of the removal of the California Filter Company to their new headquarters, 981 Folsom Street, San Francisco, Calif.

Representatives or New Lines Wanted

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

The Third Conference of the Machinery and Equipment Association is scheduled to be held at the United States Chamber of Commerce Building, February 14th.

Link-Belt Announces Three More West Coast Appointments

LAST August the Pacific Coast Division of the Link-Belt Crane and Shovel Department was opened in San Francisco by the Link-Belt Company, whose executive offices are located in Chicago. R. B. ("Buckets") Randall was made manager of this division, and Garfield & Company became agents for northern California and Nevada. At that time it was announced that several other appointments in the western terriory would follow.

In September A. H. Cox & Co., Seattle, was appointed as agent for Washington, and the National Machinery Co., Vancouver, for British Columbia. Now the announcement is made that J. L. Latture Equipment Company, Portland, has become Link-Belt crane and shovel agent for the state of Oregon and eastern Washington.

The National Machinery Company is

A. H. Cox, President

eminently fitted for handling British Columbia territory, and is ably headed by Mr. Newson as manager. All of the organizations named are well known throughout the northwest, and in addition to the Link-Belt account, they are representatives for several other leading manufacturers.

A. H. Cox & Company organized in 1910 to do a general machinery business, and in 1919 expanded and entered the construction equipment field. A. H. Cox, president, G. H. Jamison, manager of the construction equipment department, and W. F. ("Duggan") Lewis, formerly with Link-Belt Meese & Gottfried Company, are widely known in the crane and shovel industry.

The J. L. Latture Equipment Company was established in 1919. It now occupies a four-story concrete building which houses offices, display sales rooms

J. L. Latture, President

and warehouses. The president of this organization, J. L. Latture, enjoys a wide acquaintance among members of the contracting and logging industries of the northwest. The views we present with this story give a very good idea of the type of men and plants caring for the equipment machinery distribution in the far west.

The Link-Belt line of cranes and shovels, which has been supplemented by two new models within the past year, covers a range of sizes from ¾-yd. to 2 yd., each equipped and easily convertible as shovel, crane, dragline, trench shovel and skimmer excavator.

A. H. Cox & Co., Seattle

J. L. Latture Equipment Co., Portland, Ore.

Day & Maddock to Represent Erie Machine Shops

Announcement has been made of the appointment of Day & Maddock as distributors for the eastern Ohio territory for the Erie Machine Shops of Erie, Pa., manufacturers of Erie Steam and Gasoline Rollers. They will be located at West 82nd Street, south of Dennison, Cleveland, Ohio.

Linde Air Products Opens New Memphis Plant

A new oxygen producing plant was put into operation by The Linde Air Products Co., of New York, at Memphis, Tennessee, late in December. The new plant is located at 1241 North McLean Boulevard, with Mr. E. C. Heyman, superintendent of the old plant, in charge. The old plant, at 48 West McLemore Avenue, has been discontinued.

New Appointments

The Chicago Pump Company announces that the following representatives will handle their products during the coming year:

Ace Combustion & Engr. Co., 222 Milan St., Shreveport, La.; Harry Cooper Supply Co., 1224 Chemical Building, St. Louis, Mo.; F. L. Bunker, P. O. Box 1223, Greenboro, N. C.; L. Brandenberger, 149 W. 2nd St., So., Salt Lake City, Utah; Alfred P. Brown, Dexter Horton Bldg., Seattle, Wash.; John A. Butler, 18 Catherine St., Lynbrook, L. I.; Robert B. Brown, Newark, N. J.; J. J. Smith, 3620 Ednor Road, Baltimore, Md.

A Change of Address

The Southern Iron & Equipment Co., rebuilders of locomotives, cars, shovels, etc., who for the past twenty years have had their offices in the Grant Bldg. at Atlanta, Ga., have moved their general offices from the Grant Bldg. to their works at Hemphill Ave. and Southern Railway, Atlanta.

(Continued on page 40)

There is no standing still . . .

An Advertisement of the
American Telephone and Telegraph Company

During the past two years 6000 switchboards have been reconstructed in the larger cities served by the Bell System to enable the operators to give a more direct and faster service.

Previously in towns where there were more than one central office, your operator would hold you on the line while she got the operator at the other central office on an auxiliary pair of wires. Now she connects directly with the other central office and repeats the number you want to the other operator. You hear her do this so that you can correct her if there is any mistake.

This little change cost millions of dollars. Likewise, it saves millions of minutes a day for the public and it has cut down the number of errors by a third.

It is one of the many improvements in methods and appliances which are constantly being introduced to give direct, high-speed telephone service.

There is no standing still in the Bell System. Better and better telephone service at the lowest cost is the goal. Present improvements constantly going into effect are but the foundation for the greater service of the future.

"The Telephone Books are the Directory of the Nation"

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Pavement Breakers, Drills, Compressors.—Several new pieces of literature have just been issued by the Sullivan Machinery Co., 122 South Michigan Ave., Chicago, copies of which will be sent upon request. Bulletin No. 81-V describes and illustrates the new K-2 Buster, for breaking concrete. This tool provides a wide degree of utility with economy in operation. Bulletin No. 81-S contains 32 pages and is devoted to rock drills. Full description and illustrations are given of model L-7 Rotator Rock Drill, steam rotator, DP-331 and light rotator, DP-321. Both of these bulletins are on heavy enamel paper in the loose leaf style, suitable for filing with other literature. Booklet No. 2007 is an attractive broadside illustrating portable compressors (which are given more in detail in Catalog 83-F), Drills, Spaders (Catalog 81-N), Portable Hoists, and Drill Sharpeners (new Catalog 72-I). If asking for any of this literature, we would appreciate it if you would give the name of our publication.

Hydrants, Valves, Etc.—Write to the Columbian Iron Works, Chattanooga, Tenn., for descriptive literature of the Columbian Fire hydrants, Gate valves, Valve boxes, Hydrant extension sections, or other water works equipment. We would appreciate it if you would mention our publication if asking for information.

Cast Iron Pipe.—United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will be pleased to send you literature explaining the differences between the deLavaud Cast Iron Pipe and other types of pipe. This is a centrifugally cast pipe in which the graphite particles are finely divided and evenly spread.

Traffic Treads.—Alan Wood Iron & Steel Company, Widener Building, Philadelphia, Pa., have issued a new catalog illustrating and describing their "AW" Diamond Pattern Rolled Steel Traffic Treads and will be pleased to send copy upon request. These treads will be found of interest to highway officials and engineers who are put to it to prolong the life of wooden floor bridges and enable them to stand the wear and tear of modern traffic. On new bridges a traffic lane is determined upon and the treads laid accordingly, or are laid over the lines of traffic wear on old and worn floors. This company has branch offices in Boston and New York in the east, Dallas in the southwest and Seattle, San Francisco and Los Angeles in the west. Write to any of their headquarters for full particulars concerning this product. Kindly mention our magazine if writing for a catalog.

Tractors.—Caterpillar Tractor Company of San Leandro, Calif., and Peoria, Ill., has just issued a new 32-page booklet giving specifications and construction details of the new "Caterpillar" Ten. The track assembly with all its parts, the transmission, steering clutches, brakes, drive, and engine construction are thoroughly discussed. A complete list of specifications and special equipment is included. Copies of this book may be secured from the local dealers, or by writing the manufacturer. If requesting a copy of this book, kindly mention our publication.

Paver.—The Ransome Concrete Machinery Company of Dunellen, N. J., has just issued a very handsome, fully illustrated 36-page book, called "The Master Paver." A complete description is given of the Power Loader, Water Control, Drum, Drum Rollers, Discharge, Boom, Boom Bucket, Supporting Frame, Operating Levers, Engine, Gears, Shafts, Clutches, Main Frame, Crawler, Crawler Drive, Derrick, Distributing Chute and Calcium Chloride Attachment. Important parts are clearly shown in photographs, and pictures of the paver at work on specific jobs are shown, and names of the owners given. The book contains diagrams and specifications of the new Ransome 27-E, and one section is devoted to "Central Mixing Plants." If writing the manufacturer for a copy of this book, kindly give the name of our publication.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, gives a detailed description and price list of parts in all sizes of their cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating. It will cut a piece one inch long or more at any point without starting joints or otherwise disturbing the main, and will make a clean cut in a gas or water main in the trench. Write to the Tucker Company for literature and price list of the Anderson Pipe Cutting Tool. In writing, kindly give the name of our magazine.

Water Level Indicators — Weather Gages, Etc.—Several pamphlets have been received from Julien P. Friez & Sons, Baltimore, Maryland, devoted to their recorders, indicators and air gages. In the Airport Bulletin two outfits are described. For large airports a complete set of instruments for observing meteorological conditions is offered. In addition to permitting visual observation of all local weather conditions, this equipment records these conditions graphically on charts. A complete picture of the weather is thus furnished. Equipment No. 2 is an economical combination of instruments for airports when complete meteorological records are not desired. The Bulletin "Telaugage" describes the Au Water Level Indicator for remote indications of levels of all impounded and flowing waters. The development of the self-synchronizing electric motor has made possible the accurate transmission of this information automatically and its reproduction, several miles away if necessary, on dials graduated to show changes as small as one-hundredth of a foot. For literature on these Recorders, Indicators and Airport instruments write Julien P. Friez & Sons, Baltimore, Md., mention our publication.

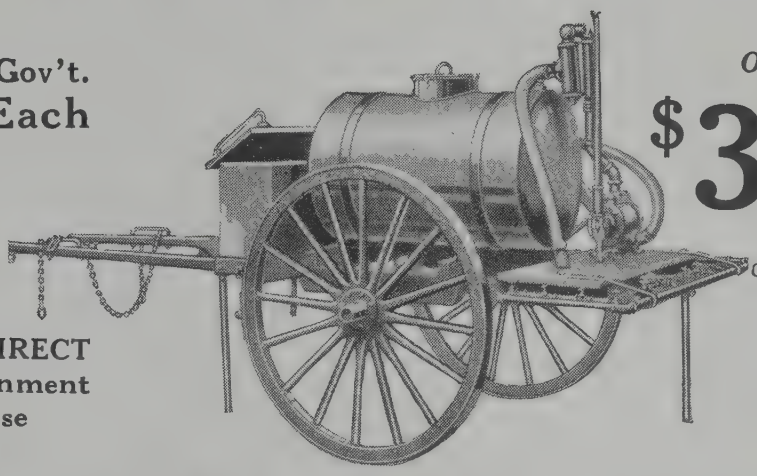
Electrical Testing. — The Wagner Electric Corporation of St. Louis, Missouri, has just issued the fourth edition of its bulletin on Manual of Electrical Testing, a 20-page bulletin on testing single phase and polyphase motors, and testing transformers for core loss, copper loss, polarity, insulation, temperature rise and efficiency. This is a loose leaf style bulletin suitable for binding with other literature. The bulletin gives the addresses of the offices of this corporation located in all the principal cities from coast to coast. If writing for a copy of this particular bulletin specify No. 138. We would appreciate it if you would give the name of our magazine.

Municipal Refuse Incinerators.—The Hiler Engineering & Construction Co., Inc., 122 Livingston Street, Brooklyn, N. Y., has issued a very attractive little 24-page booklet on the Heenan System of Municipal Refuse Incinerators. This system of municipal waste disposal was made the recognized standard in the United States in 1906 after one of the most exhaustive studies of the problem had been made, covering existing plants in this country and abroad. Illustrations and descriptions are given of the plants in use in the

(Continued on page 42)

U. S. GOV'T. WATER CARTS At a Give-away Price

Cost U. S. Gov't. $275.00 Each



ONLY

$37.50

F. O. B. Columbus, Ohio

Horse Drawn

Shipping Weight 1600 Lbs., Crated

SHIPPED DIRECT From Government Warehouse

A Cart With Many Uses

These Water or Tank Carts are part of the U. S. Gov't surplus stock—they are brand new, have never been used—cost $275.00 each and we now offer them to you at the almost give-away price of only $37.50.

Think of it!—a 150 Gallon, Heavy Gauge Galvanized Iron Tank Cart, equipped with Double Acting Gould Force Pump—25 ft. of 2″ hose—16 Brass Faucets, etc. Strong, Sturdy 54″ Wheels, Steel Hubs and Axle—for less than 1/6 what the Government originally paid for them!

These Carts are horse drawn—and make the ideal equipment for sprinkling walks or roadways—for sprinkling and spraying flowers, trees and shrubbery—for hauling water, gasoline or oil—a real handy utility Tank Cart with dozens of uses.

Send us check or money order for $37.50 and we will send you one of these Water Carts, in its original crate, just as it was delivered to the U. S. Gov't by the Studebaker Wagon Works or other high grade manufacturer who built it.

Note These FEATURES

Made for the U. S. Gov't by the Studebaker Wagon Works and other high grade Wagon Builders. Never used—comes to you in original crates just as delivered to the U. S. Gov't Warehouse. A mighty useful and handy outfit. Tank is of heavy gauge one-piece galvanized iron, with splash partitions, solid riveted joints, capacity 150 gallons, Gould Double Acting Force Pump, extra large strainer—25 ft. of 2-inch hose (we do not guarantee condition of hose, yet it may give considerable service); wheels 54 inches in diameter, 3-inch steel tires, 10-inch steel hubs; tread 56 inch, steel axle 2x2 in.; foot brakes, tool box under seat; 15 brass faucets in rear for drawing off contents and one extra large master faucet.

For Spraying

Easily converted into a sprayer. By making a few changes in the pipe connection, this outfit can be converted into an air pressure sprayer worth at least $300.00. Instructions sent with each cart.

Guaranteed Exactly as Represented

You take absolutely no risk in ordering these carts. The publishers of this paper have inspected these Carts and know the splendid value represented in these carts and the opportunity for its subscribers to get the greatest Bargain ever offered. Remember, these carts have never been used—come to you just as delivered to U. S. Government. They are EASILY WORTH SIX TIMES THE PRICE WE ASK.

We can't begin to tell you in this ad the wonderful value represented in these Tank Carts—they must be seen to be appreciated. We do know that after you get one, you wouldn't sell it for several times the low price you paid for it. Many who have ordered one, after receiving it and seeing its splendid value and the many uses to which it could be put, have immediately ordered from one to three more. Send your order now.

National Jobbing & Export Co. Dept. Z, 192 N. Clark St. Chicago, Illinois

principal cities. At Buffalo, N. Y., is the largest incinerator plant in this country which represents the latest type of the Heenan System and which has the most complete and effective equipment for the handling and destroying of 500 tons of Mixed Garbage and Rubbish in 24 hours. Write for literature on this system.

Western Hot Patch Plant.—A product of the Austin-Western Road Machinery Company, 400 North Michigan Avenue, Chicago, for keeping roads in repair winter and summer. Write to their Chicago office or any branch office for their Bulletin on Winter Repair Work for particulars concerning this equipment. We would appreciate it if you would mention our magazine.

Cast Iron Pipe.—The McWane Cast Iron Pipe Company of Birmingham, Alabama, will be pleased to send upon request, illustrated literature giving full information concerning their product, its cost, life and uses. The western branch of this organization is the Pacific States Cast Iron Pipe Company of Provo, Utah.

Aerator.—The Simplex Surface Aerator, an effective means of producing "activated Sludge," is fully described in Bulletin E-5-28, issued by the Simplex Ejector and Aerator Corporation. The Chicago address is 2528 W. Madison St., Chicago. If writing for literature, kindly mention our magazine.

Automatic Air-Lift. — The Sullivan Machinery Company, 130 South Michigan Avenue, Chicago, has a handbook on their automatic air lift, and special automatic control information of particular interest to water works superintendents. Their catalogs also describe air made wells, and contain a complete story of how a city elected a mayor on his promise to get them well water, and how his promise was kept by the use of this method. Kindly mention our publication when requesting catalogs.

Layne Well Systems. — Write to Layne & Bowler, Inc., Memphis, Tenn., for information concerning their guaranteed pumps and screens. We would appreciate if it you would use the name of our paper if writing for particulars.

Wrought Iron Pipe.—"The Installation Cost of Pipe" is the title of a Bulletin issued by the A. M. Byers Company, Pittsburgh, Pa., containing cost data and full particulars concerning this product and its uses. Ask for Bulletin No. 38, giving the name of our magazine.

Trimo.—The trade name by which the wrenches manufactured by the Tremont Manufacturing Company, Inc., are known. These pipe wrenches are made with a braced frame to stand the hardest strain, with hard biting jaws that can be easily renewed, and the heat treated steel handles assure tremendous strength. Write for detailed information and prices to Roxbury (Boston), Mass., mentioning the name of this magazine.

Gate Valves.—The Darling Valve & Mfg. Company, with offices in New York, Chicago, Houston and Oklahoma City and headquarters in Williamsport, Pa., will be pleased to send you literature on the construction and operation of the Darling Gate Valves. If writing for particulars on this product, kindly mention our paper.

Deep Well Works.—The United Iron Works, Inc., of Springfield, Mo., with general offices in Kansas City, manufacturers of "Pomona" double stroke deep well power pumps, offer without obligation methods for economically solving pumping problems. The engineering experts will be pleased to advise with you. Descriptive catalogs will be sent upon request. If writing, kindly give the name of our magazine.

Pumps. — New Catalog containing complete information on centrifugal pumps, plunger pumps, and deep well power heads may now be obtained by writing the American Well Works, Aurora, Illinois. Their engineering department will be pleased to discuss your needs with you, recommending the best equipment for your purposes. Kindly use the name of our publication if writing for information.

Mono-Cast Pipe. — The trademark name of the American Cast Iron Pipe Company for a centrifugal cast iron pipe made in a refractory mold, was chosen because only one second is required to transform the molten metal into pipe by this method. Write to the Birmingham office of this company, or to their branches in the principal cities for literature on this product. Ask for information on Mono-Cast Cast Iron Pipe, giving the name of our magazine.

Disposal Plants. — Fairbanks-Morse and Co., Chicago, or any of their branch offices in the principal cities will be pleased to furnish complete details concerning their F-M Trash pumps for handling unscreened sewage direct from sewers. Write for information, giving the name of our publication.

Excavators.—Write to the Bucyrus-Erie Company at Erie, Pa., or to their branches in any of the principal cities for information concerning the performance of their excavating machines. This will give you a gauge by which to measure the work you are now able to do, with the records of other equipment.

Ejectors.—The Shone Sewage Ejectors, manufactured by Yeomans Brothers, 1423 Dayton Street, Chicago, are in use in all quarters of the globe with long service records to their credit. Write to this company for literature giving the special features which enter into the merits of this equipment.

Cast Iron Pipe.—"The Two-Main System" is the title of a book which The Cast Iron Pipe Research Association is distributing free to city officials, engineers and taxpayers. It is a pocket size volume, written in non-technical style, with charts, drawings and photographs to make the telling more forceful. It explains how the two-main system is able to meet the demand of the taxpayer for a means of preventing the tearing up of costly streets for extensions, repairs, etc. A valuable book for public officials and engineers. Write to Mr. Thos. F. Wolfe, Research Engineer, Peoples Gas Bldg., The Cast Iron Pipe Research Association, for a copy of this book, kindly mentioning the name of our paper.

Clay Pipe.—The Clay Products Association, Conway Building, Chicago, makers of vitrified clay pipe, will be pleased to send you full information regarding this product.

Meters — Gauges — Valves. — Information on complete equipment for filtration plants may be secured by writing the Simplex Valve & Meter Company, 6749 Upland Street, Philadelphia, Pa. The Simplex Rate of Flow Controller is adaptable to large and small filter plants from 30-inch effuent to 3-inch. The Simplex Venture Type Meter indicates, records and totalizes the rate of flow, and the Simplex Filter Gauges may be had in many combinations of Indicating, Recording and Totalizing. If writing for particulars on this equipment, kindly mention our magazine.

Filtration Plants.—Norwood Engineering Company, Florence, Mass., will be pleased to send you full particulars regarding the Norwood Municipal Filtration Plants. Kindly give the name of our publication if requesting information.

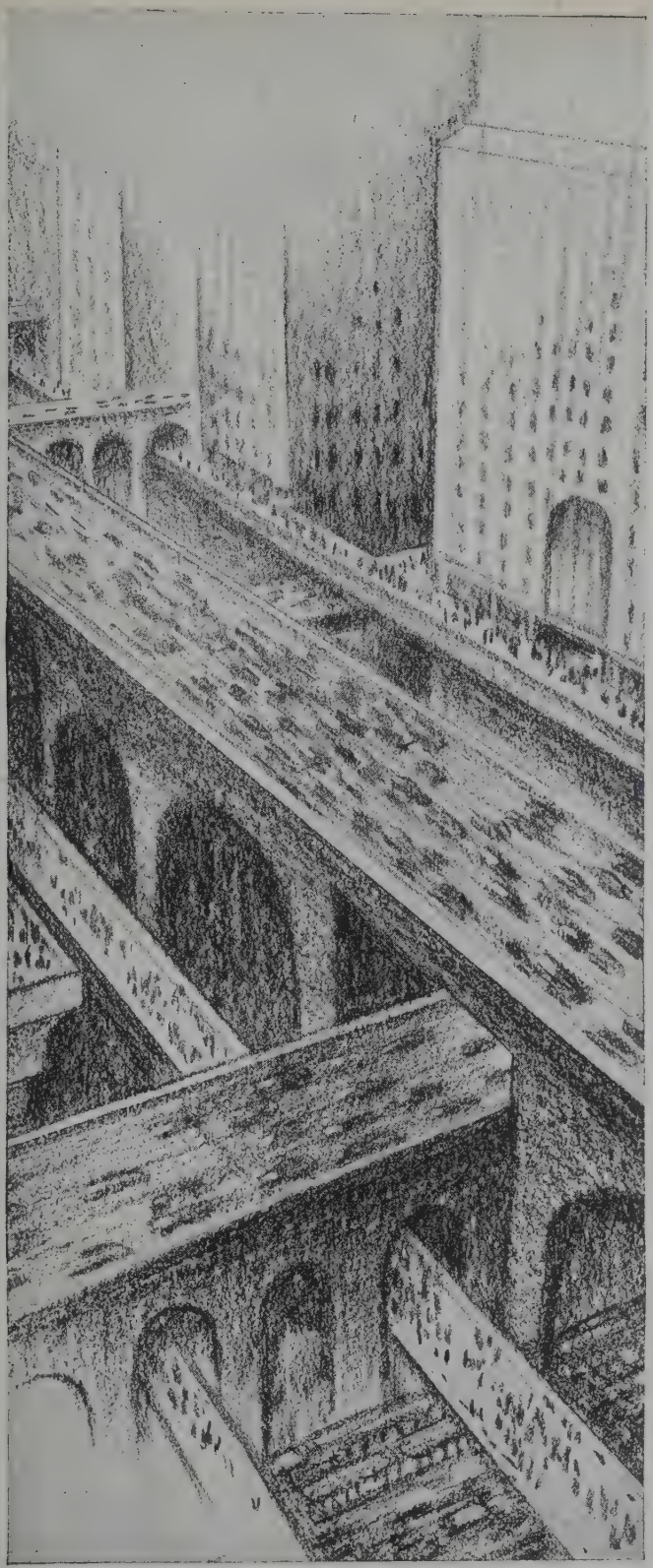
Steel Tanks.—A new Water Works Catalog has been issued by the Pittsburgh-Des Moines Steel Company, 906 Tuttle St., Des Moines, and 4 Neville Island, Pittsburgh, Pa., with branches in the principal cities. These elevated steel tanks insure a large supply of water at any and all times. If desiring information, ask for Catalog No. 2, kindly giving the name of our magazine.

Pipe Cutter.—Manufactured in two sizes for all types of pipe by the Ellis & Ford Mfg. Co., 18 Piquette Ave., Detroit, Mich. Circular giving full particulars will be sent by manufacturer upon request. We would appreciate it if you would mention our magazine, if writing.

Meter Boxes.—The Ford Meter Box Company of Wabash, Indiana, have a special bulletin on the Ford Type S Meter Boxes for "warmer climates." Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently handled.

Centrifugal Pumps. — Catalog-W-67

(Continued on page 44)



FOR CITIES WHICH LOOK 100 YEARS AHEAD

CITIES looking a century ahead are planning to meet problems undreamed of a decade ago. Problems involving underground and surface transportation . . . . pedestrian and motor traffic . . . . the interlocking problem of proper gas and water systems.

The streets of the future need never be torn up for pipe replacements. For cast iron pipe may be laid and forgotten. Cast Iron pipe's full span of life has never been measured. Mains that have served a century, two centuries, and longer, are still in service.

Cast Iron Pipe made by the members of The Cast Iron Pipe Research Association is manufactured under laboratory control to the modern standards of the Association members. The Association offers to taxpayers, city officials and engineers, information on every subject pertaining to the use of pipe for water, gas, sewers, road culverts and for industrial needs. All information is supplied without cost or obligation. Address: Thomas F. Wolfe, Research Engineer, Peoples Gas Building, Chicago.

CAST IRON PIPE

issued by DeLaval Steam Turbine Co., Trenton, N. J., gives methods of meeting water supply problems at the lowest cost. Full information regarding geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. If writing for a copy of this booklet, kindly give the name of our publication.

Hydraulic Supplies.—Write to the Reading Meter Repair Company, Inc., Reading, Pa., for prices and particulars regarding testing or repairing water meters, using the name of this magazine.

Air Pump.—The Indiana Air Pump Company of Indianapolis, Ind., will be pleased to send upon request a catalog giving details regarding construction and operation of air-lift method of pumping wells. If writing this company, kindly give the name of our publication.

Porous Concrete Well.—Upon receipt of a request E. Thorpe, 1932 Illinois Avenue, East St. Louis, will send you a folder describing the advantages of the porous concrete well. With this information they send a list of satisfied users of this type well.

Force Pumps.—Bulletin 28-MF has just been issued by the Domestic Engine & Pump Co., Shippensburg, Pa., giving specifications and types of their pressure force pump units.

Adensite.—A liquid integral compound used in the gauging water for Portland cement concrete and mortar, is described in a folder recently issued by the Adensite Co., Inc., 116 West 39th St., New York. The folder contains many illustrations showing where the product has been used, and a list of buildings where installations have been made. Write for full particulars concerning this product to the manufacturer, giving the name of our magazine.

Sanitary Specialities.—Manufactured by the Servicised Products Corporation include Bituminous rope, sewer compound and sewer belts (both acid and root proof), and asphalt liner slabs, proof against sewer liquors. Illustrated literature giving complete descriptions and details concerning these products for obtaining permanently tight and lasting sewers will be sent upon request by the Servicised Products Corporation, 6051 West 65th Street, Chicago, Ill. If you will mention our publication when writing to Mr. A. C. Fischer of the Servicised Company for this information it would be greatly appreciated.

Moir-Buchanan Centrifugal Process.—This process is to obtain high density, low absorption and long life of concrete pipe. Rights to use this process may be secured through the Asphalto-Concrete Corporation, 1440 Broadway, New York City. If interested in learning about this process and how strength and durability are secured by this method write to Mr. Geo. H. Schroder of the Asphalto-Concrete Corporation, using the name of our magazine and ask for full particulars.

Chlorinator.—Bulletin W-21 issued by the Paradon Manufacturing Company of Arlington, N. J., describes in detail the Paradon Chlorinators for city and private water and sewage systems, industrial plants and swimming pools. If writing for this bulletin address Mr. R. V. Donnelly, care of the manufacturer. We would appreciate it if you would mention our publication.

Centrifugal Pumps.—In order to be of assistance to users in choosing the right pump for their needs, Bulletin 1632-I has been issued by the Allis-Chalmers, Milwaukee, Wis. Types for steam turbine drive, motor drive or gasoline engine drive are described to best fit the purposes of installation. Write to Mr. H. G. Hoffman for copy of this bulletin, mentioning Municipal News and Water Works.

Dragline.—Write to Koehring Company at Milwaukee, Wis., or to any of their branches in the principal cities, for Dragline Bulletin DL9. The ease of control and speed in functioning are important features of this heavy duty Koehring equipment. Mr. O. C. Dahlman will furnish bulletin on request. If writing mention our magazine.

Cast Iron Pipe.—James B. Clow & Sons, 201-299 North Talman Avenue, Chicago, with foundries at Coshocton, Ohio, Newcomerstown, Ohio, and Birmingham, Alabama, carry large stock of pipe at points where large supplies can be obtained on short notice. Wire or write them concerning your requirements, they will be glad to care for your needs without delay. Mention our magazine when writing this company.

Cast Iron Pipe.—The Central Foundry Company, manufacturers of cast iron pipe with offices located in the principal cities, will be pleased to have you call at the nearest office or write to the New York office, 420 Lexington Avenue, for complete information in regard to their product, an iron to iron joined pipe, allowing for expansion and contraction, vibration and uneven ground settlement. Used for water supply, fire protection and other service.

Hydrants and Valves.—The Mathews Fire Hydrants, built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia. If you will write to Mr. C. Becker of this company he will gladly send you full information about their sand-cast and "sand-spun" centrifugal cast iron pipe fittings, valves, boxes and hydrants. Please use the name of our magazine if writing.

Lubricant.—The Dot Lubricant Equipment Company, Division of the Carr Fastener Company, Cambridge, Mass., has issued a unique little folder called "Little Journeys in Dot Lubrication," illustrating and describing the various steps in the use of this lubricant. The trip described is that of taking the grease from the storage tank to the bearings quickly, comfortably for the user, absolutely free from dust and dirt.

Meters.—The Union Water Meter Company of Worcester, Mass., with offices in New York City and Philadelphia, will be pleased to send you literature concerning their King Frost Protected Meter, built to overcome every known weakness in frost meter design. If interested in meters of this type write to Mr. E. K. Otis for full particulars. We would appreciate it if you would mention this publication.

Valves.—Golden-Anderson Valve Specialty Company located in the Fulton Building, Pittsburgh, have issued a descriptive and data catalog on their automatic valves for steam and water service. Full details are given on each page as to construction, operation variations together with cross-section drawings. Data required for ordering is made very clear. If you desire a copy of this catalog write to Mr. J. A. Voland of the Golden-Anderson Company mentioning the name of our magazine.

Francois Cementation Process.—The Dravo Contracting Co. have acquired the sole American rights to the Francois patents, and have a highly skilled staff who will be pleased to help you with your problems. This method of grouting covers chemical processes for a hundred and one different cases, the engineers of the Dravo Company are ready to help you solve your problems. Write to their company at Pittsburgh, Pa., mentioning our magazine.

Hydrants, Valves, etc.—Full particulars for supplies needed by water works and fire departments will be sent upon request by the Bourbon Copper & Brass Works Co., 618 E. Front St., Cincinnati, Ohio, manufacturers of fire hydrants, gate valves, and extension valve boxes. Write for their catalog, giving the name of our magazine.

Sewer Cleaning Machine.—W. H. Stewart, whose factory is at Walkerville, Ontario, has branches in St. Louis, Mo., Jacksonville, Fla., and Boston, Mass., so that his patrons on this side of the border may be served without paying duty. Literature describing his sewer and conduit rods will be furnished on request. Rods will be shipped on trial. If writing to Mr. Stewart for information concerning his equipment kindly mention our publication.

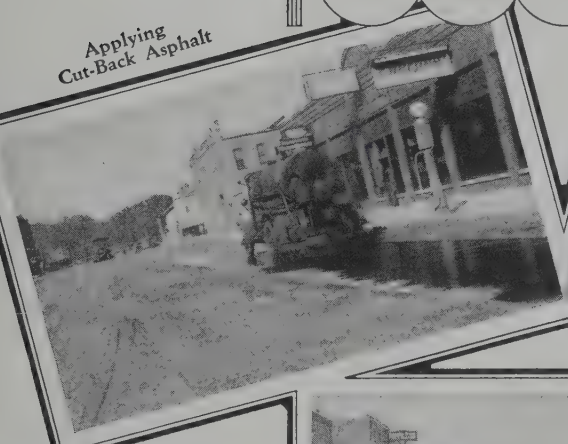
Zeolite.—"Softening Municipal Water Supplies by the Use of Zeolite" is the title of a bulletin issued by the Zeolite Chemical Company, 140 Cedar Street, New York City. This booklet describes Green Sand, a natural base exchange Zeolite Mineral, used for the purpose stated. Write to Mr. R. E. Wagner of the Zeolite Company for a copy of this bulletin. If writing, we would appreciate it if you would mention this magazine.

(Continued on page 46)

THE durability and economy of highways surfaced with Stanolind Cut-Back Asphalt has been well demonstrated on many roads throughout the Middle West.

Main Street at Hutchinson, Minn., was surfaced with Stanolind Cut-Back Asphalt, using 3/10 of a gallon per square yard, and 20 pounds of Torpedo Gravel per square yard. Roller was used to surface.

Applying Cut-Back Asphalt



Spreading covering material

Completed Roadway

Stanolind Cut-Back Asphalt

asphalts for every purpose

STANDARD OIL COMPANY *(Indiana)*

General Offices: 910 South Michigan Avenue CHICAGO, ILLINOIS

ILLINOIS
Chicago
Decatur
Joliet
Peoria
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INDIANA
Evansville
Indianapolis
South Bend

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WISCONSIN
La Crosse
Milwaukee
Green Bay

IOWA
Davenport
Des Moines

Mason City
Sioux City

S. DAKOTA
Huron

N. DAKOTA
Fargo
Minot

MICHIGAN
Detroit
Grand Rapids
Saginaw

MINNESOTA
Duluth
Mankato
Minneapolis

MISSOURI
Kansas City
St. Joseph
St. Louis

214

Manhole and Catch Basin Covers.—Write to Wm. E. Dee Company, 30 North La Salle, Chicago, Ill., for particulars concerning the different types of manhole and catch basin covers. Prices will be included on request. If writing, kindly use the name of our magazine.

Chlorination.—Wallace & Tiernan, Newark, New Jersey, manufacturers of chlorine control apparatus will be pleased to send you full particulars in regard to the sterilization of water by their method, and to furnish you with record of cities where their apparatus is being used. If writing for information, we would like to have you mention our magazine.

Rayflectors.—The trade name of patented reflecting devices designed for utilizing light from automobile headlights, or other outside sources, to make signs and signals visible at night. The Rayflectors are manufactured by the Ray-Signs Corporation, of New Haven, Connecticut, and are described and well illustrated in a very attractive, well bound, 12-page booklet. These devices come in three sizes and in white, red, green and amber. This black and gold booklet will be sent upon request by the manufacturer, and we would appreciate it if you would mention our publication when writing.

Lubrication.—The story of the Alemite Manufacturing Corporation system of lubrication issued in magazine style. This pamplet, Lubrication Maintenance, is published in the interest of better industrial lubrication and lower production costs, and will be mailed free to any one interested. If writing for this booklet, will you kindly mention our publication? The address of the Alemite Manufacturing Company is 2646 North Crawford Avenue, Chicago.

Valves.—The Darling Valve & Mfg. Company with offices in New York, Chicago, Houston and Oklahoma City and headquarters in Williamsport, Pa., will be pleased to send you full information in regard to the design and performance of their valves which are built to minimize friction and wear. If writing for literature to Mr. A. G. Smith at the Williamsport office of the company, kindly use the name of our magazine.

Bags.—Let the Bates Valve Bag Corporation, 35 Wacker Drive, Chicago, tell you about their multi-wall-paper bags in a very attractive folder which they have recently issued. These bags are proving of inestimable value to the contractor in protecting his plaster from losses by the elements. This company also manufactures the Bates Ties and Tools for the use of contractors in speeding up reinforced concrete work, by fast, tight, non-slipping ties requiring no special skill to apply. Write to this company for their latest literature, mentioning the name of our publication when writing.

Electric Power.—A very attractive forty-eight page booklet, well bound and profusely illustrated, is now being distributed by the Electric Machinery Manufacturing Company of Minneapolis, Minnesota. It is devoted to the subject of power factor correction with capacitors (static condensers). The title of the book is "Reducing the Cost of Electric Power" and gives a non-technical explanation of power factor and shows when and how to apply capacitors to reduce electric power cost. It also explains the construction of capacitors. This company has offices in all the principal cities where copies of this book may be secured, or from their main office at Minneapolis.

Dredges.—Catalog E issued by the Norbom Engineering Co., Darby, Pa., gives full particulars concerning the Norbom Hydraulic Dredges. These dredges will be built to suit your special requirements. Write for a catalog giving the name of our magazine.

Inertol.—This is a waterproofing and anticorrosive compound for impregnating concrete surfaces and for protecting steel, making the structures waterproof under pressure and immune against aggressive chemicals. This is manufactured by the Inertol Company, Inc., 253 Broadway, New York City, and stocks are carried in Newark, N. J., Chicago and San Francisco. In color it is a glossy black and comes ready for use, and needs no skill in applying, but is used cold with brush or paint sprayer. An illustrated broadside has just been received from this company giving the many uses for this product, prices, etc. Write to the manufacturer for full information, mentioning this magazine.

Meter Testers.—A catalog giving complete information on the Mueller Meter Tester will be sent upon request if you will write to Mr. C. N. Wagenseller of Decatur, Illinois, mentioning this publication, or they may be secured at any of the branch offices of this company. The Mueller Meter Testers are simple of operation and of a lasting quality of construction. Statistics show that meters under-register oftener than they over-register and an accurate meter tester insures honestly earned revenues. Meters should be tested before installation and at regular periods thereafter. The Mueller catalog will give you complete information on this subject.

Hydraulic Dredge Capacity Indicator.—The Ellicott Machine Corporation, 1111 Bush Street, Baltimore, Maryland, specialists in dredging outfits, are equipped to furnish you with well designed hydraulic dredge, either diesel, electric, gasoline or steam driven, built for efficient and economical service. Mr. C. E. Ellicott, Jr., will be pleased to furnish you full information concerning outfits for jobs of all sizes. If you will mention this magazine, he will send for your convenience a hydraulic dredge capacity indicator.

Governors.—How to increase production and profits and lower operating costs, by the use of Pierce Governors, is described in Booklet No. 14, issued by the Pierce Governor Company, of Anderson, Indiana. This equipment on power engines results in a smooth, uniform flow of power to meet every load. Fuel, operating and repair bills are reduced and the life of engines prolonged. Mr. D. J. Nolan, of the Pierce Governor Company, will be pleased to send you a copy of this booklet, and we should be pleased if you would mention our magazine when writing.

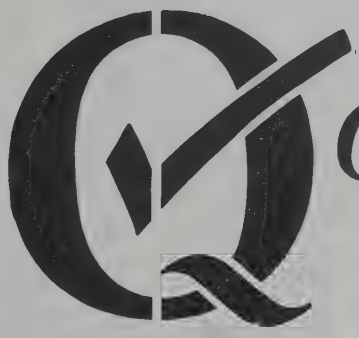
Portable Compressors.—Ingersoll Rand Company, 11 Broadway, New York City, will be glad to send you catalog describing their gasoline engine or electric driven portable compressors in six sizes. If writing for this information, will you please mention our magazine.

Steel Sheet Piling.—Lackawana Steel Sheet Piling, particularly suitable for the long sea wall. For information regarding this product write to the Bethlehem Steel Company, Bethlehem, Pa. Mr. S. H. Yorks is sales-manager. In writing Mr. Yorks, give the name of our magazine.

Pumps, Engines, Hoists.—If you have hoisting problems, write to Mr. Clarence E. Bement, of the Novo Engine Company, 200 Porter Street, Lansing, Michigan, asking for a free copy of Novo Hoisting Handbook. This is not a catalog but a book of useful information for the man who must meet hoisting problems. They will also be glad to send you full particulars concerning their entire line of products.

Lumber.—For the users of lumber the National Lumber Manufacturers Association, Transportation Building, Washington, D. C., has much valuable information in booklet form, which they will be glad to send you. Bulletin No. 16 is called "Simplified Practice" and another booklet containing much general information is called "Information on Lumber and Where to Find It." Either of these booklets will be sent without obligation by addressing the company at Dept. 4651, at the address given above. If applying for a copy kindly use the name of our magazine.

Water Softeners.—The International Filter Company, 333 West 25th Place, Chicago, present in an illustrated bulletin Crystalite, a water softening product. This is an attractive 16 page booklet, well printed on heavy enamel paper. It discusses the chemistry of zeolite water softening; the early history and development of zeolites; Crystalite as a super rapid zeolite; the advantages of upflow softening illustrated with curves. Crystalite Water Softeners installed by the International Filter Company are illustrated, and special industrial uses for Crystalite are listed. If writing for this bulletin, kindly mention our magazine.

"ACIPCO" Products Are All *Quality*  *Checked*

As one of the pioneer pipe founders who helped establish modern standards of cast iron pipe manufacture—affiliated with the Cast Iron Pipe Research Association—this company will hereafter emblazon all of its products with the "Q-check" trade mark of that Association.

This "Q-check" mark appearing on our pipe is but a new, outward symbol of that old, inherent quality which has characterized Acipco products for a quarter century.

Tens of millions of feet of our pipe are now in service. The men who laid this tremendous footage have already checked our products for quality. To these we present this "Q-check" mark as a guarantee of continued satisfaction. To those who have never used our pipe, we offer this "Q-check" mark as an official endorsement of our products. To all concerned with the use of pipe for water, gas, sewers, road culverts, etc., we submit this reminder: Don't forget to look for the "Q-check" mark and you can forget the pipe after you've laid it!

The symbol shown above has been adopted as a trade mark by the Cast Iron Pipe Research Association with which this company is affiliated. Insist on the "Q-check" mark when specifying cast iron pipe for gas, water, sewer, or industrial use.

—o—

"ACIPCO" OFFICES

DALLAS · · · CHICAGO
LOS ANGELES
MINNEAPOLIS KANSAS CITY
SAN FRANCISCO
NEW YORK CITY SEATTLE

This company is affiliated with the Cast Iron Pipe Research Association—a service organization of leading pipe founders, formed to promote the scientific improvement and use of Cast Iron Pipe. Taxpayers, city officials and engineers may obtain full information on the use of pipe for water, gas, sewers, road culverts and industrial needs by writing our home office at Birmingham, Alabama.

AMERICAN CAST IRON PIPE COMPANY

BIRMINGHAM, ALABAMA

DISTRICT OFFICES IN PRINCIPAL CITIES

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Station GCG

This is the Gillette Construction Group broadcasting from our headquarters in Chicago, the news and views of distributors and manufacturers in the field of construction engineering. Every month 70,000 receiving sets throughout the world, made up of 27,000 readers of Engineering and Contracting; 27,000 readers of Roads and Streets, and 16,000 readers of Municipal News and Water Works are able to enjoy these tri-monthly broadcasts, which are sent to them through the interest and courtesy of makers and distributors of all kinds of equipment machinery.

Distributors and manufacturers in all lines of construction engineering products have served as announcers over this station. We want them to continue to let us hear from them. There are many more with interesting stories to tell who have not yet been heard over GCG. Just send your items and pictures to The Editor, Distributor News, Gillette Publishing Company, 221 E. 20th St., Chicago, and they will be broadcast over Station GCG, which has no wave length limit. Please stand by for Distributor News items coming through GCG March issue of Municipal News and Water Works.

Ashcraft Is Sauerman Representative

Since last December the sale of Sauerman equipment in western Pennsylvania and the adjoining border counties in Ohio and West Virginia has been handled by Charles E. Ashcraft, 335 Fifth Ave. (the State Theater Building), Pittsburgh.

Mr. Ashcraft, formerly engineer and salesman for the Beckwith Machinery Company, has designed plants and furnished equipment for hundreds of contract jobs and industrial projects in the district. He had charge of many Sauerman installations made by the Beckwith Company so is well informed on their slackline cableways and power drag scrapers.

He is a native of Kentucky and holds a civil engineering degree from the University of Cincinnati. Before taking his degree he had much experience in practical engineering, such as surveying, architecture, building construction and railroad engineering. He has worked with the United States Engineers on the design and construction of works of navigation, as superintendent of construction with the Foundation

Charles E. Ashcraft

Company, and as general superintendent of construction for the Baker-Dunbar-Allen Company.

He has been identified with many important slackway water developments and the operation and care of works of navigation on the Monongahela River. New Lock No. 4, Monongahela River, which was probably the most important work of which he had charge, now has the distinction of passing more tonnage than any lock in the world, except the locks at Sault Ste. Marie, Mich.

After many years spent in contracting work, during which time Mr. Ashcraft engaged in building various kinds of structures such as retaining walls, docks, trestles, coal tipples, water intakes, pump pits, etc., he decided to abandon the roaming life of a construction man and naturally turned to the field of selling construction equipment. So it happened that he joined the Beckwith Machinery Company at a time when they were establishing advisory engineering service for the benefit of their contracting and industrial clientele. This consultation work with contractors and engineers, involving the designing of all kinds of structures, required a theory and practice in a field of engineering construction which Mr. Ashcraft's wide experience enabled him to bring to it.

The fact that the Beckwith Company has withdrawn from the sale of Sauerman equipment, owing to a desire to concentrate largely on the sale of tra tors and tractor auxiliary equipme was the reason of Mr. Ashcraft's resi nation from that company and his a rangement with Sauerman Bros., I He will now devote his entire time Sauerman equipment. His services c be of great benefit to aggregate pr ducers, industrial plants, contracto and other users of slackline cablewa and power drag scrapers, for his expe ence makes him familiar not only wi the details of applying this equipme but also with the many other proble with which these clients are co fronted.

H. W. Moore Equipment C Establish Wyoming Branch

The H. W. Moore Equipment C of Denver, Col., well known distri utors of construction and road buil ing machinery, have recently organiz a company under the laws of the Sta of Wyoming, to be known as the H. Moore Equipment Co. of Wyoming.

The new company, which is locat at 421 W. 17th St., Cheyenne, will under the management of Mr. John Wortham, who is also treasurer of t company. Among the lines which w be represented in Wyoming are: Gali leaning and straight wheel grade road rollers and maintainers; Ced Rapids crushers, screens and conveyo Schramm compressors; Jaeger concre mixers; General excavators; Mari steam shovels; Lakewood grade ro ers, concrete and asphalt finishers a clamshell buckets; Baker snow plo and maintainers; Wehr "One Ma power maintainers; Chausse asph and tar heating equipment; Super S ney steel plows, fresnos, slips; Atl conveyors, etc.

The officers of the H. W. Moo Equipment Co. of Wyoming, Inc., a Mr. George L. Meffley, president; J. Moore, vice-president and secreta and J. R. Wortham, treasurer.

Mr. Moore states that the reason f starting a branch in Cheyenne is b cause they believe the development the State of Wyoming now justifi such a venture and that results, so f have been very satisfactory. Until t year, Mr. Moore says, there has be no equipment house in the state. small stock of equipment and repa will be carried in Cheyenne, which w assure service to the Cheyenne cu tomers.

CAST IRON PIPE

THE symbol shown above has been adopted as the trade mark of The Cast Iron Pipe Research Association. Cast iron pipe with age-defying qualities acknowledged for generations, plus the improvements which scientific research has introduced, can hereafter be identified by this symbol. It will appear on cast iron pipe made by the leading pipe founders listed below. Insist on the "Q-Check" mark when you buy cast iron pipe, whether for gas, water, sewer, or industrial service.

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and proper use of cast iron pipe. Pipe bearing the "Q-Check" mark may be obtained from the following: American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe & Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Cast Iron Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

The Cast Iron Pipe Research Association, Thomas F. Wolfe,
Research Engineer, Peoples Gas Building, Chicago.

See advertisements in March 9th Saturday Evening Post; March 11th Time and March 23rd Collier's.

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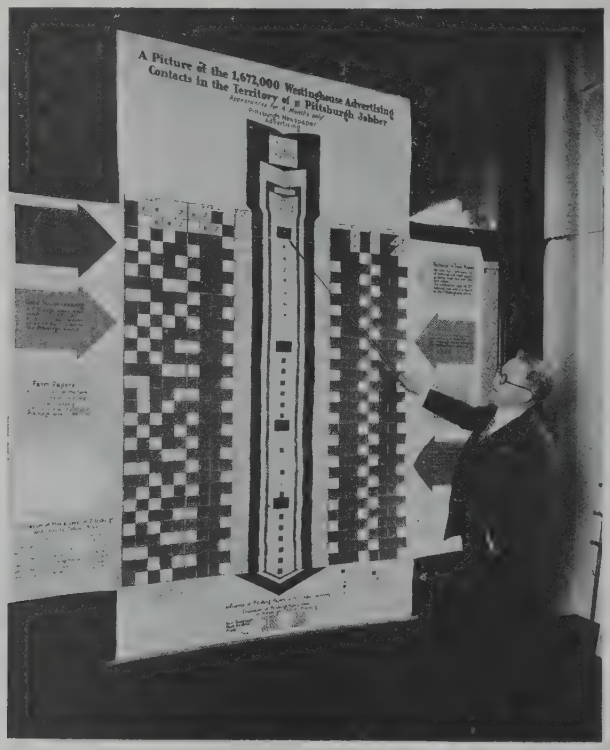
Westinghouse Increases Advertising Program In Techanical Journals

According to a statement issued by Mr. J. C. McQuiston, general advertising manager of the Westinghouse Electric and Manufacturing Company, a greatly expanded program of advertising for 1929 in the technical, trade and business publications has been decided upon.

"The increase," states Mr. McQuiston, "in the number of products from year to year which we manufacture has made it advisable for us to change our technical advertising to keep step." He believes that leading industries offer a market for a large number of Westinghouse products, and it is the plan to use group advertisements to call to the attention of executives in an industry, the whole line of equipment suitable for that industry. The story of Westinghouse service will be emphasized in a series of messages presented in technical magazines.

The aim of the advertising policy for expanding the electrical industry, as outlined by Mr. McQuiston, is to educate the public concerning the vital part that electricity plays in modern civilization, and to cooperate directly with distributors of electrical products in advertising programs, as a direct service to distributors.

The field of advertising media to be used, includes business and technical magazines, farm papers, financial publications and school and college papers. For general institutional and consumer advertising continued use will be made of newspapers on a considerably expanded scale. An interesting feature mentioned in connection with the plan for the use of newspapers is the Sunday rotogravure advertising, which up to this time has never been used for this purpose.



J. C. McQuiston, General Advertising Manager of the Westinghouse Electric and Manufacturing Company, Perfects New Form of Chart by Which He Knows in Detail Months in Advance Where Each Advertisement Will Appear and at the Same Time Has a Complete Picture of His Entire Campaign Before Him. This Chart Was Prepared for Use in the Westinghouse Company's 1929 Advertising Program.

T. W. Rosholt Company To Handle Tracksons

Trackson Tractor Equipment for the McCormick-Deering Industrial Tractor will be represented in the north central section of the country by Thorman W. Rosholt Company, 928 S. Fourth St., Minneapolis, according to an announcement of the Trackson Company, Milwaukee, Wis.

The territory to be represented by the Rosholt Company includes Fargo and Grand Forks, N. D.; Winona, St. Cloud, Minneapolis and Mankato, Minn., and Eau Claire, Wis., where the International Harvester Company maintain branches.

Stocks of Trackson full-crawlers, loaders, shovels, cranes, bulldozers, etc., will be carried, as well as repair and replacement parts.

New Department Manager For H. O. Penn Machinery Co.

Mr. M. V. Rider, formerly New York sales manager for the T. L. Smith Company, has joined the H. O. Penn Machinery Co., of New York, as manager of their road building department. He will handle the sales of all road construction equipment for them.

George Haiss Mfg. Co. Announces New Distributors

The Equipment Company of Boston, Mass., has been made distributor for the George Haiss Mfg. Co., Inc., New York, for eastern Massachusetts, Rhode Island and the southeastern part of New Hampshire.

The northern and eastern parts of Florida will be covered for the Haiss Company by the Coulter-Hart Equipment Company, of Tampa, Fla.

W. C. Caye & Company Will Represent Erie Machine Shops in Georgia

Announcement is made of the appointment of W. C. Caye & Co., 158 Walker St., Atlanta, Ga., as distributor for the Erie Machine Shops, Erie, Pa., manufacturers of Erie steam and gasoline rollers.

Trimont Mfg. Company Makes Purchase

The Trimont Mfg. Co. of Roxbury, Boston, Mass., has purchased the Stillson wrench business of the Moore Drop Forging Company of Springfield, Mass., and will continue the manufacture of both the Original Pattern and Popular type Stillson wrenches.

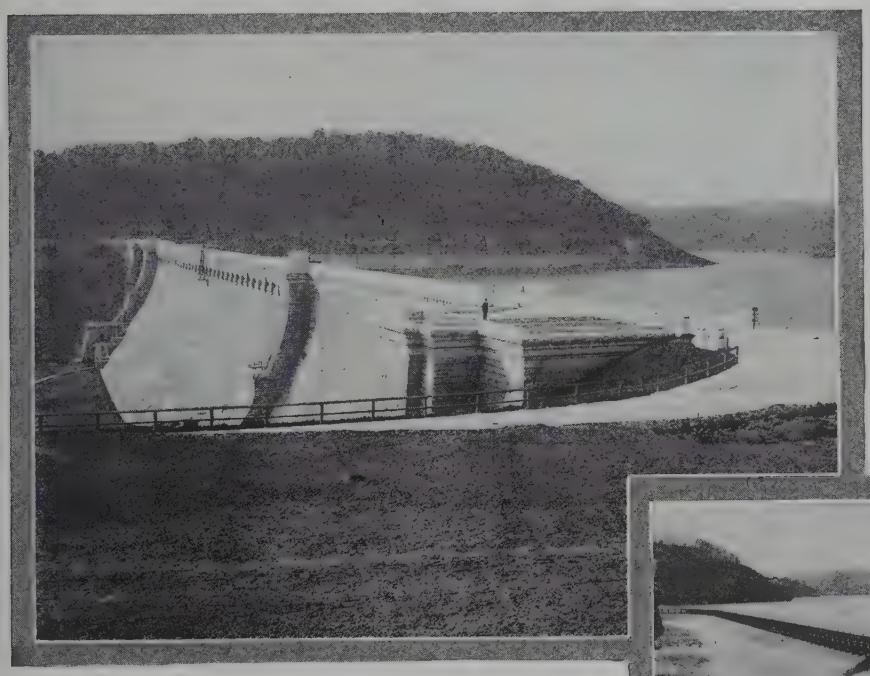
The Morco Original Pattern Stillson will, under Trimont manufacture, be known as SANDO Original Pattern Stillson and the Marco Popular will hereafter be known as MOROCO Popular.

All of the Trimont Company's 40 years' experience in the making of fine tools goes into the forging, hardening and other manufacturing processes of these Stillson wrenches and both will compare favorably in quality and price with other Stillsons of their type now on the market.

The Dow Chemical Company of Midland, Mich., announce the appointment of Mr. Donald Williams as assistant sales manager to succeed Mr. S. W. Putnam, whose resignation was accepted in December.

MILLIONS WERE SPENT

to construct this New York Water Supply System



Croton Dam and Spillway, part of the extensive storage system which assures New York's millions an unfailing supply of pure water.

MUNICIPAL governments spend millions of dollars annually to protect the water supply of their communities. Reservoirs, aqueducts and filtration plants are maintained at tremendous expense to insure a permanent supply of pure, clear water. But, unless that water reaches the faucets in the same pure state in which it leaves the reservoir, these safeguards are practically destroyed.

That is why it is so important to use Copper or Brass for service pipe. Pipe made of these metals *cannot* rust. Its use eliminates the health menace of rust-contaminated water, the expense of replacements and the damage to pavements that must be torn up when repairs are made.

Although the initial cost is somewhat higher than that of the rustable or so called *rust-resisting* kind, Copper or Brass pipe is an economy in the long run. With them, the first cost is the last. Once installed, they will serve *without attention* for generations.

Before you order service pipe write for our interesting booklet "WATER SERVICES THAT SERVE."

COPPER & BRASS
RESEARCH ASSOCIATION

25 Broadway, New York

Midwestern Office: Landreth Building, St. Louis, Mo.
Canadian Office: 67 Yonge Street, Toronto, Ont.
Pacific Coast Office: Architects Building, Los Angeles, Cal.

COPPER, BRASS, BRONZE — *The World's Most Useful Metals*

Michigan Valve & Foundry Purchased by Banking Interests

According to recent information, control of the Michigan Valve and Foundry Company of Detroit has been purchased by Chicago and Detroit banking interests. A meeting was held on February 11th, when the new company was organized and officers and directors elected.

Serving on the Board of Directors is Mr. Thomas Neal, who was chairman of the board of General Motors from 1912 to 1915 and who is at present chairman of the board of the Equitable Trust Company of Detroit and a director of the First National Bank of Detroit; Mr. Neil B. Dawes who is a partner in the Chicago banking house of Lane, Roloson and Company; Mr. J. Russell Forgan, a partner in the Chicago banking house of Brokaw and Company; Mr. E. S. Jackson, formerly with the Chrysler organization as auditor; Mr. F. W. Marschner, formerly with the Chalmers Motor Car Company and American Motor Car Company, who has been western manager of the New Departure branch of General Motors Corporation; Mr. R. J. Goldie who has been in the automotive industry for a number of years with Chalmers Motor Car Company, Timken-Detroit Axle Company, and has recently been engaged in consulting engineering work; Mr. W. F. Rockwell, president of the Pittsburgh Equitable Meter Company, the Wisconsin Parts Company, and the American Water Meter Institute, and is a director in the Kensington Water Company, Tri-Cities Water Company, Timken-Detroit Axle Company, Pittsburgh Employers' Association, and chairman of the Distribution Equipment Managers Division of the American Gas Association.

Mr. R. J. Goldie will have active charge of the company's business, serving as vice-president and general manager. The other officers of the company are: Mr. W. F. Rockwell, president and chairman of the board, and Mr. E. S. Jackson, secretary-treasurer.

Established in 1869 as the Galvin Brass and Iron Works, the Michigan Valve and Foundry Company has been well known to the water works industry since its formation. The company was a pioneer in valve and hydrant design and manufacture. It is expected that the new company will adopt a vigorous expansion policy, and announcements of sales offices may be looked for in the near future. It is reported that new machinery is being installed and the capacity of the plant enlarged, and a large amount of business has been booked for immediate delivery where approximately four hundred men are now employed. The company owns some valuable patents and according to announcement will manufacture new lines as well as continue the manufacture of the old lines.

G. H. Jamison, Manager of the Construction Equipment Department of A. H. Cox & Company, Equipment Distributors Located at Seattle, Washington. Cox & Company Represent the Link-Belt Company in Their Territory.

Secretary Davis Speaks at Ground Breaking for Byers Plant

On Feb. 11 formal recognition was taken of the ground breaking for the new $10,000,000 plant which the A. M. Byers Co., of Pittsburgh, Pa., is to construct at Ambridge, Pa. The following excerpts are given from the remarks of Secretary of Labor James Davis as significant of what the Byers New Process might mean to the ferrous industry:

"Heretofore the effort had been to create a machine that would imitate the movements of a human worker. All such efforts failed. Now the metallurgist has stepped in and brought success. He has known better than to try making a machine take the place of a man. Instead of a machine he has invented a process. And where the machine always failed, the process works.

"The part of it which has convinced me of its success is the dropping of the old idea of the 'heat' and substituting a ball of iron weighing 2,500 to 3,000 weight, and making this in a short time.

"There is a saving, too, because under the old method, in the production of 2,500 to 3,000 weight of iron, with two crop ends to the ball, three balls to the heat, and five heats to a day, there were thirty crop ends, but with this new process there are but two crop ends to the same weight. And while, as just stated, it formerly required a day's labor to produce this weight of iron, it can now be produced in half an hour.

"This new process will mean increased production, too; which means giving employment to more men, cheapening the cost of iron so that more of it can be sold and used, and perhaps opening new industries for the working of iron into new products, with still further extension of new jobs to new men.

"In the long run every new process or method or machine that improves or speeds production and cuts down its cost in money and labor, is a boon to humanity."

Southern Plants of Acetylene Products Co. Acquired by Prest-O-Lite Co.

The two acetylene producing plants, formerly owned by the Acetylene Products Co., located at 401 E. Buchanan St., Phoenix, Ariz., and 914 Texas St., El Paso, Tex., have been acquired by the Prest-O-Lite Co., Inc.

These plants are now being operated as units of the Prest-O-Lite chain, which brings the number of plants operated by this company up to 38. These centrally located plants are able to supply the local demand for dissolved acetylene used in welding and cutting.

Mr. Everett R. Kirkland is superintendent of the Phoenix plant, and Mr. Carl F. Chesak is superintendent of the El Paso plant. Mr. R. C. Dagett, whose headquarters are at the San Francisco office, is district superintendent.

Engineers Incorporate

Mr. W. N. Brown of Washington, D. C., who for a number of years has specialized in geodetic and topographic mapping, has announced a firm incorporation to be known as W. N. Brown, Incorporated. Mr. Brown, who is well known as a mining and civil engineer, will have associated with him Mr. A. F. Brooke, Mr. H. V. Jacobs and Mr. W. T. Brown. Offices will be maintained in the Architects Building, 1800 E. Street, N. W. Mr. Brooke and Mr. Jacobs have been associated with Mr. Brown for several years past.

Some of the important accomplishments of Mr. Brown have been: the topographic mapping of the City of Cincinnati, the topographic survey of Naval Reserve No. 1, surveys of large areas along the Mississippi River for flood prevention, and surveys for hydroelectric developments in North Carolina and West Virginia. He is now engaged in revising the topographic survey of the City of Louisville, Ky., covering an area of approximately 40 square miles.

McEverlast Opens Chicago Office

Mr. Lee S. Trainor has been named district manager for the newly opened Chicago office of McEverlast, Inc., Los Angeles, Cal. Mr. Trainor will be located at 35 East Wacker Drive.

A-2437 Valve Box Cover. Tires cannot displace this "Stay-Put" Clow Valve Box Cover.

A-2425 Valve Box — adjustable to any variation in depth of valve. Made in 3 sections of heavy gray iron, thickly tarred.

By ordering valve boxes with pipe often a full car can be made up and the carload rate procured.

even

"Less Carload Lots"

are shipped without delay from the

World's Largest Stock

Clow carries the world's largest and most complete stock of cast iron pipe and fittings. Clow immediately ships orders of any size from this huge stock.

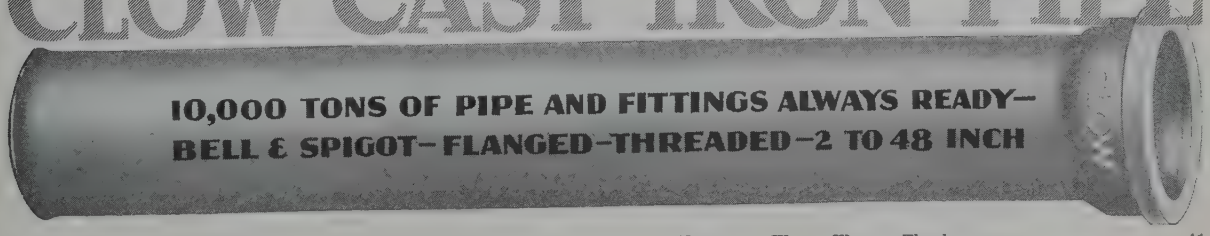
Clow maintains stock at strategic shipping points, cutting down shipping costs on "Less Carload Lots."

Clow always *carries in stock* such special fittings as split sleeves, offsets, half circle pipe, cutting-in-tees, valve boxes, test plugs, Eddy valves and hydrants, and also: bell and spigot, flanged, and threaded pipe, tools, lead and oakum.

You can save precious waiting time—save transportation costs on L. C. L.—with orders to Clow, and speed up installation time with special Clow fittings.

JAMES B. CLOW & SONS, 201-299 N. Talman Avenue, CHICAGO
Foundries at: Coshocton, Ohio : Newcomerstown, Ohio : Birmingham, Alabama

CLOW CAST IRON PIPE



Representatives or New Lines Wanted

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Executive with 20 years' experience in selling contractors' and builders' machinery and equipment, is starting new organization and would like to hear from manufacturers desiring representation in Northern California.

Distributor Notes from Barber-Greene

An office has been opened at 527-528 Merchants National Bank Bldg., Cedar Rapids, Ia., by the Barber-Greene Company of Aurora, Ill., manufacturers of ditchers, loaders, conveyors, coal equipment, etc. Mr. Jack Marson of the Barber-Greene Company will have supervision of this office. Mr. Marson has been with the Barber-Greene Company for a number of years.

Another branch office under the supervision of Mr. Marson has been opened at 1106 Nicholas St., Omaha, Neb. Mr. W. E. Toole is in direct charge of this office.

Distributor Notes from Domestic Engine & Pump

Howard E. Read Corporation, 800 N. Delaware Ave., Philadelphia, is to serve that territory as distributor for the complete line of "Domestic Dependable Power Pumps."

The Western Contractors Supply Company, who represent this manufacturer in the Chicago territory, has opened a branch in Indianapolis, Ind., under the managership of Mr. C. F. Messenger. This branch will probably handle the same lines they have been representing in Chicago.

American Hoist & Derrick Appoints Export Sales Manager

The American Hoist & Derrick Company, whose works and main office are at St. Paul, Minn., announces the appointment of Mr. F. E. Bauer, Jr., as export sales manager with offices at 50 Church St., New York City. Mr. Bauer has represented the American Hoist & Derrick Company in foreign fields for many years and has a wide knowledge of business conditions in Asia and the Orient.

C. M. Taylor Becomes Sales Manager for Lincoln Electric

Announcement has been made by the Lincoln Electric Company, Cleveland, O., of the appointment of Mr. C. M. Taylor as sales manager.

Mr. Taylor is a graduate of Western Reserve University and served in the United States Army Air Corps during the war. In 1923 he became factory manager for Lincoln Electric, in whose employ he had been since his college graduation, with the exception of his period of service in the army.

He was elected as vice-president of the company in 1925. The Lincoln Electric are manufacturers of "Stable-Arc" welders and "Linc-Weld" motors.

Bay City Dredge Works Now Bay City Shovels, Inc.

For the purpose of more clearly indicating its present principal type of product (convertible power shovels), the Bay City Dredge Works of Bay City, Mich., announces the corporate name will hereafter be Bay City Shovels, Inc. The announcement from the company states that no change of policy or ownership is contemplated, and the ownership, direction and management of the company will remain in the hands of the individuals who organized and developed the original institution.

Ziegler Company Opens Branch in Fargo

Mr. O. H. Strand, who has been with the Wm. H. Ziegler Company of Minneapolis, Minn., has been placed in charge of a branch office which this company has opened in Fargo, N. D.

Mr. Strand will represent the accounts which the Minneapolis office handles, including a complete line of contractor's equipment, coal handling machines and all kinds of material-handling machines. Among the accounts are Barber-Greene, Bucyrus-Erie, Chain Belt, Sterling Wheelbarrow, Williams Buckets, Plymouth Locomotives, Butler Bins, etc.

Inland Lime & Stone Co. Announces Plans

Inland Lime & Stone Co., a subsidiary of the Inland Steel Co., has announced plans for the development of a large quarry near Manistique, Mich., for the production of chemical and metallurgical lime. It is expected that the quarry will be in production late next year.

The company has also announced plans for the construction of a new harbor near this quarry. Work will commence when navigation opens in the spring.

Road Oil properly applied develops Good Roads at the lowest cost

You can obtain smooth, dustless dirt or gravel roads by properly applying Standard Asphalt Road Oil to the surface.

Standard Road Oil will waterproof the roadway, making a firm, durable surface at all seasons and under all weather conditions. And the cost is low.

Photographs show Wisconsin State Highway No. 35, west of Galesville, being treated with Standard Asphalt Road Oil.

LISTEN IN

CHICAGO SYMPHONY ORCHESTRA
Sunday Evening 6 to 7 o'clock, Central Standard Time
Over following:

WGN Chicago	WOW Omaha	WOC Davenport
WTMJ Milwaukee	WEBC Superior	WDAF Kan. City
WHO Des Moines	KSTP St. Paul	KSD St. Louis

Sweeping, after loose gravel has been bladed to shoulder.

Applying and blading Standard Asphalt Road Oil No. 4 and gravel. Road under traffic while treating.

Eight weeks after treating we still have a matless oil road. Traffic up to 2,500 cars per day.

STANDARD OIL COMPANY (*Indiana*)

General Offices: **910 South Michigan Ave.** **Chicago, Illinois**

ILLINOIS	INDIANA	IOWA	S. DAKOTA	MICHIGAN	MINNESOTA	MISSOURI	WISCONSIN
Chicago	Evansville	Davenport	Huron	Detroit	Duluth	Kansas City	La Crosse
Decatur	Indianapolis	Des Moines	N. DAKOTA	Grand Rapids	Mankato	St. Joseph	Milwaukee
Joliet	South Bend	Mason City	Fargo	Saginaw	Minneapolis	St. Louis	Green Bay
Peoria	KANSAS	Sioux City	Minot				
Quincy	Wichita						

215

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Portable Compressors.—Bulletin 797, now in its fourth edition, has just been issued by the Chicago Pneumatic Tool Company, 6 East 44th St., New York. The Chicago Pneumatic Portable Compressors, gasoline engine driven are now made in five sizes, viz.: 100, 160, 220, 265 and 310 cu. ft. free air per minute. This equipment is fully described and illustrated in the Bulletin referred to. If writing the manufacturer for a copy, we would appreciate it if you would mention our publication.

Compressors, Drill Sharpeners, Pneumatic Tools.—The Sullivan Machinery Company, 122 South Michigan Avenue, Chicago, Ill., will be pleased to send you a copy of their new eight-page folder, Form 2007, calling special attention to their portable air compressors, mounted to suit your requirements; drills, spaders, hoists and sharpener—all illustrated and described. Catalogs will also be sent upon request, write for information. Kindly mention our magazine, if writing manufacturer,

Paver.—A compact little booklet of 16 pages has just been issued by the Koehring Company, Milwaukee, Wis., on the new 27-E Paver. Each section of this paver is illustrated and described in detail. The new Greater Koehring 27 E is 11 ft. 3 in. high, weighs 22 tons and has great stability because of low center of gravity. Booklet is called The Greater Koehring Paver. Write manufacturer for a copy, mentioning our paper.

Chemicals.—The Hooker Electrochemical Company of 25 Pine St., New York City, or Tacoma, Wash., will be pleased to send you literature concerning the Hooker chemicals. Among the products of this company are listed: Caustic Soda, Liquid Chlorine, Bleaching Powder, Muriatic Acid, Monochlorbenzine, Paradichlorbenzine, Benzoate of Soda, Benzoyl Chloride, Ferric Chloride, etc. Plants are located at Niagara Falls and Tacoma. If writing manufacture, kindly give the name of our paper.

Meter Boxes.—If you will write to H. W. Clark Company, Mattoon, Ill., they will be pleased to send you catalog No. 24, giving full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for access for repair work or replacements. If requesting copy of catalog, kindly mention our magazine.

Automatic Control Valves.—The Ross Valve Mfg. Co., Inc., Archibald St., Troy, N. Y., will be pleased to furnish you with particulars regarding their automatic pressure control valves for feed water filters, portable fire hydrants, hydraulic engines, hydraulic booster pumps, etc. Write for information, giving the name of our publication.

Sewage Ejectors.—Write for catalog of the Pacific Flush-Tank Co., Ravenswood Ave., Chicago, or 9 Park Place, New York, giving complete information regarding Miller Flush Tank Siphons, sewage pumps and ejectors, portable diaphragm sludge pumps, sewer joint compound, etc.

Cast Iron Pipe.—National Cast Iron Pipe Company, Birmingham, Ala., will be pleased to send you particulars in regard to cast iron pipe for water and gas. Pipe made by sand cast and deLavaud centrifugal processes, also fittings and 2-in. cast iron service pipe. Branches in the principal cities.

Filtration Plants.—The Norwood Engineering Company, Florence, Mass., has much information on the installation of filtration plants which they would be pleased to send you if interested in municipal plants. Write for records of Norwood Municipal Filtration Plants. Kindly mention our magazine.

Reinforced Concrete Pipe.—The Lock Joint Pipe Company, Ampere, N. J., would be pleased to send you full particulars concerning Lock Joint Reinforced Pressure Pipe; its permanence, high carrying capacity, tightness, expansion joints, etc.

Sluice Gates.—Coldwell-Wilcox Company, South Water St., Newburg, N. Y., manufacturers of sluice gates, sheer, flap and butterfly valves, flexible joints, etc., will be pleased to send you full information concerning any of these products. If writing for catalog, kindly mention our paper.

Concrete Pipe.—Write to the Asphalto-Concrete Corporation, 1440 Broadway, New York City, for full information and manufacturing rights for the use of the Moir-Buchanan Centrifugal Process of making concrete pipe. Low manufacturing costs, low laying costs, high density, low absorption and long pipe life are features of this product.

Chlorinator.—The Paradon Manufacturing Company, Arlington, N. J., has issued Bulletin W-22, describing in detail the Paradon Chlorinators for city and private water and sewage systems, industrial plants and swimming pools. If writing for a copy of this bulletin, we would appreciate it if you would mention our magazine.

Rust-Proof Pipe.—"Water Services that Serve" is the title of a booklet issued by the Copper and Brass Research Association, 25 Broadway, New York City. This booklet is a treatise on the need and way of securing a pipe which will withstand soil corrosion on the outside and internal corrosion from the flow of water on the inside. A copy of this booklet will be sent you upon request. If requesting a copy, kindly mention our publication.

Centrifugal Pumps.—The Byron Jackson Pump Co., Berkeley, Calif., with branches in the large cities, will be pleased to send you literature on their sewage pumps, designed for wet or dry pit operation, and which will pass any solid that can enter the pump. The oversize bearings are lubricated from the surface and are protected from pressure fluid by special arrangement of ports. If writing the manufacturer, kindly mention our magazine.

Water Meters.—Write to the Badger Meter Manufacturing Company, Milwaukee, Wis., for detailed bulletin on their complete line of meters, ranging in size from the smallest disc to the 12-in. turbine. This information will point out the way to reduce your pumping costs, by the use of the Badger Turbine Meter at the pumping station and the meters on the service lines. Many changes were made during the past year to increase efficiency and serviceability. If writing for literature, kindly mention our magazine.

Excavator.—Write to the Bucyrus-Erie Company, South Milwaukee, Wis., or Erie, Pa., for bulletin on their D-2 Diesel Drag-Shovel. This shovel is built for the hardest work at a minimum cost. Easily convertible to clamshell-crane, shovel or dragline. Manufacturer will be pleased to furnish you with performance records of this equipment.

Automatic Valve Control.—Cutler-Hammer, Inc., Milwaukee, Wis., has issued their second edition of "Modern Valve Control Practice," describing the C-H automatic valve control system. The new edition contains much additional information and data. There are also new photographs to show the use and installation of motor-driven valves. One of the outstanding features shown in the book is the operation of all valves throughout the plant by means of push-

? What will the years do for you?

? What will **YOU** do with the Years?

Become A Building Estimator

You might doggedly *blast* your way upward in this well paid profession. But the heartbreaking discouragement and years of struggle are unnecessary. To save all this, the Tamblyn System was developed by Gordon C. Tamblyn, who has been building foreman, construction superintendent, estimator, and finally a successful contractor. He learned there is always a shortage of good reliable estimators to protect the contractor's profits. As a result he offers in his System a thoroughly practical training you can follow at your own pace at home. You will gain a thorough knowledge of subjects essential to success at the top of the building industry. As you progress with the course, you progress in a business way. On completion of the work you are fitted for a responsible position as Building Estimator. But you won't stop there—And to start,—now, today, at once—the first step is finding out the details, without the slightest obligation.

This System is an aid, not only to young men determined to make their mark in the building field, but is used by many—

Architects
Superintendents of Construction
Foremen
Engineers and Contractors

A booklet "Your Road Map to Comfort, Security and Prosperity" outlines the upward steps in the building industry, which the Tamblyn System makes clear and easy. Send the coupon for this booklet.

Send us the coupon.

TAMBLYN SYSTEM

Builder's Course in Plan Reading, Quantity Surveying and Estimating

Gillette Publishing Co.,
221 E. 20th St., Chicago, Ill.

Please send me, without obligation, the booklet telling of opportunities opened up by The Tamblyn System.

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W W-3-29

buttons from a single centralized control board. The book also explains in detail the construction and the operating principle of the C-H automatic valve control system, including the new unit for small valves. This is a very comprehensive booklet on the subject and every plant engineer should have a copy, which the manufacturer will be pleased to send upon request. Kindly mention our magazine if asking for copy of bulletin.

Boothal.—This is a water clarifying coagulant, put out by the Booth Chemical Company, Elizabeth, N. J. It is composed of an aluminum salt and the proper proportion of alkali to completely precipitate the alumina. The kind of alkali used is dependent upon requirements. It is particularly well adapted for use in the purification of waters of low alkalinity for public supplies, paper mills, bleacheries, etc. It is shipped in sealed rope paper bags, 60 lb. net, and the package may readily be emptied into the hopper of any suitable dry feed apparatus for application to the water to be coagulated. The feeding is thus more accurate than where solutions are used and less labor is required. The factory of the manufacturer is located at Townley, N. J., but mail is received at Elizabeth, N. J. The manufacturer will be pleased to send you pamphlet giving much information in regard to the use of Boothal, and to point out the economy and simplicity of their system of coagulation. If writing for literature or information, kindly mention our magazine.

Water Purification Equipment.—A booklet has been issued by the International Filter Company, 333 West 25th Place, Chicago, which is a catalog of International Water Purification Equipment and also contains much general information concerning water softening and filtration plants. It is bound in loose leaf style, made up from a series of bulletins, dealing in detail with disc filters; concrete gravity and wood tank type gravity filters; pressure filters; swimming pool filteration; neutralizers; steam purifiers; hot flow water softeners; exchange type (zeolite) water softeners; water purification for ice making, etc. There are several pages devoted to International sales and service, and blank questionnaires to be filled out and mailed in to enable the manufacturer to assist you in solving your problems. The manufacturer will be pleased to send you this complete and comprehensive booklet upon request. Kindly mention our name if asking for copy.

Water Filters.—Information on gravity and pressure plants for all capacities will be furnished you upon request, by the Roberts Filter Mfg. Co., 632 Columbia Ave., Darby, Pa. If writing for information, kindly give the name of our magazine.

Hydraulic Packing.—For water works purposes, on centrifugal or reciprocating pumps and hydraulic valves, write for information concerning Mabbs Rawhide Packing. This packing never becomes hard or glazed. Manufactured by the Mabbs Hydraulic Packing Company, 431 S. Dearborn St., Chicago.

Gas Main Stopper.—The Safety Gas Main Stopper Co., 523 Atlantic Ave., Brooklyn, N. Y., will be pleased to furnish you with particulars on the use of the Goodman Cylindrical Stopper, to stop the flow in sewers. Write for information, giving the name of our publication.

Filter Sands and Gravel.—To meet the most rigid specifiactions on this product write to the Northern Gravel Company, Muscatine, Ia., for information on their "Standard."

Castings.—Write to the South Bend Foundry Company, South Bend, Ind., for information concerning their patented chilled manhole covers. Information furnished on all kinds of gray iron castings.

Valve Housings.—S. E. T. Valve & Hydrant Company, 50 Church St., New York City, will be pleased to send, upon request, descriptive literature on their cast iron sectional valve housings, built in different sizes and depths. This company makes a complete line of municipal street castings and will furnish catalog if desired.

"The Cleaning of Water Mains."—This is the title of a booklet issued by the National Water Main Cleaning Company, 32 Church St., New York, describing the method so successfully used by them for the past twenty years. Write for a copy, giving the name of our magazine.

Hydro-tite.—This is a modern joint material for self-calking joints, for bell and spigot pipe joints, manufactured by the Hydraulic Development Comapny, 50 Church St., New York. Write for particulars.

Service Boxes, Wrenches, Lids, Keys, Etc.—A circular from the H. W. Clark Company, of Mattoon, Ill., manufacturers of water works necessities, describes their Type A, B and M service boxes. They would be pleased to hear from you with specifications and requirements, as their engineers will be glad to help you work out equipment best suited to your needs. Clark wrenches, plugs, service box keys and repair lids are all described in this literature. Ask for folder V-11-3M, and kindly mention our name if writing manufacturer.

"Oxwelding Pressure Vessels" is the title of a booklet just issued by The Linde Air Products Company, 30 East 42nd St., New York City. This is a copyrighted article of the Linde Air Products Company, being a reprint from Oxy-Acetylene Tips of January, 1929. It is an 8-page article dealing with welding problems from the angles of experience, selection of material, design, preparation and technique, inspection and test, and what procedure control has accomplished. This booklet will be sent upon request without charge. If writing the manufacturer for a copy, kindly mention our magazine.

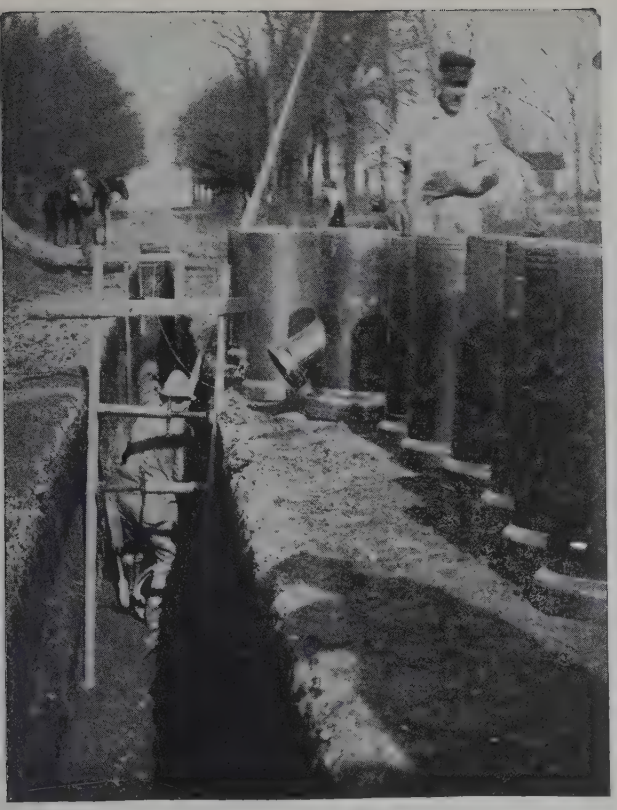
Flood Lights.—"Light Where You Want It" is the title of a little booklet issued by the National Carbide Sales Corporation, 342 Madison Ave., New York City. Construction, sizes, operation, and portability are set forth in this booklet. The National Carbide Lantern, for use of contractors, street repair gangs, tunnel workmen, etc., is described in a folder. This literature, together with prices, will be sent by the manufacturer upon request.

Valves.—Westcott Hub End Valves, manufactured by the Westcott Valve Co., East St. Louis, Ill., are described in a folder issued by the manufacturer. There are but four working parts, the stem, the disc nut and two rocker back discs. Write to manufacturer for full information concerning this product, mentioning our magazine.

Dosing Tank Counter, Sewage Tees, Nozzles, Etc.—Bulletin No. 100, issued by the Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, contains full descriptions, table of weights and price list of this equipment. The new dosing counter for checking the amount of sewage treated by keeping count of the number of times the dosing tanks have discharged may be mounted on the roof of the tank or attached by brackets to the side wall. The counter is protected by a weather-proof cover and has been operated in all kinds of weather. For complete information about the Marley Sewage Tees for sprinkling filter beds and nozzles of the threaded spindle type, lock spindle type and spindle and half spray plug, write to the manufacturer. If requesting literature on this equipment, we would appreciate it if you would mention our magazine. The New York office of this company is at 9 Park Place.

Compressors.—The Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, Ill., has issued a new handbook on Compressed Air Practice, containing numerous suggested uses for compressed air as an aid to speeding production and improving products. It also contains helpful information concerning piping, lubrication and the care of compressed air equipment. The manufacturer will be pleased to send a copy of this book upon request, and we would appreciate it if you would mention our publication if writing.

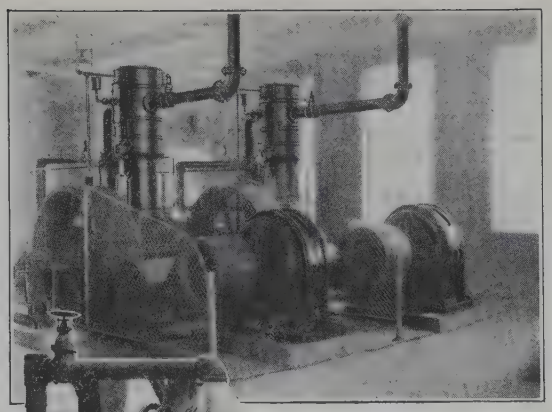
Industrial Engines.—Bulletin No. 201 has been issued by the Weber Engine Company, Kansas City, Mo. This is a horizontal, 2-cycle, single cylinder, medium compression engine, of comparatively light weight, designed and constructed to insure the greatest strength and rigidity. For users requiring power units of 30-hp., 40-hp., 60-hp., 80-hp., 100-hp. and 125-hp. it affords a thoroughly reliable, compact and economical oil or gas engine of great simplicity. This engine is adaptable for water, sand, drainage or irrigation pumps, electric



Make sure your sons don't have to pay for sewers they never had

CLAY PRODUCTS ASSOCIATION
CONWAY BUILDING
Chicago

VITRIFIED Salt Glazed **CLAY**
Sanitary Sewer Pipe MN&WW 3-Gray



"No Permanent Well Water Available," they thought—

—But Sullivan Air Lift Air Made Wells gave Amarillo 7 Million Gallons Daily

Amarillo, Texas, needed more water. An impounded, treated, slack tasting supply would not do. The people wanted well water. And they elected a new mayor on his promise to get it.

Palo Duro Canyon, a nearby tract of land was available. Underlying it was a 25-foot bed of fine quicksand, saturated with water. It lay only 145 feet from the surface.

But wells previously drilled in the canyon had failed. Sand clogged the screens. The wells fell off to less than 90 g.p.m. In some places the sand was pumped out—and the overlying clay caved into the wells.

Nobody thought the sand strata of Palo Duro Canyon could yield a permanent water supply. But a 20-inch "Air Made" Well, pumped by Sullivan Air Lift was installed. It started at 60 g.p.m. In three weeks it was producing 700 g.p.m.

The "Air Made" Well process removed the sand and inserted coarse gravel. Every day the well grew stronger. The city was convinced.

Nine more "Air Made" Wells were installed. Their daily capacity is seven million gallons. And a system of back-blowing repeated at intervals, keeps the wells free from sand—and the water flow ever-increasing.

Sullivan Air Lift has solved many water problems. If your wells slow up—if you are tired of pulling sucker rods and working barrels—if you are having trouble with varying water levels or crooked wells—if you are interested in a water system that has no moving parts in the well to need inspection or repair—investigate modern Sullivan Air Lift. Complete Amarillo story, and Air Lift Booklets are free on request.

Sullivan Machinery Company
130 S. Michigan Ave., Chicago

SULLIVAN TRADE MARK

generators, air compressors, rock crushers, pipe line machinery, mills and industrial plants. The bulletin contains illustrations and cross-sectional drawings and full description. Write for a copy of this bulletin, kindly mentioning our magazine.

Hydrants, Valves, Etc.—Write to the Columbian Iron Works, Chattanooga, Tenn., for descriptive literature of the Columbian Fire hydrants, Gate valves, Valve boxes, Hydrant extension sections, or other water works equipment. We would appreciate it if you would mention our publication if asking for information.

Cast Iron Pipe.—United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will be pleased to send you literature explaining the differences between the deLavaud Cast Iron Pipe and other types of pipe. This is a centrifugally cast pipe in which the graphite particles are finely divided and evenly spread.

Paver.—The Ransome Concrete Machinery Company of Dunellen, N. J., has just issued a very handsome, fully illustrated 36-page book, called "The Master Paver." A complete description is given of the Power Loader, Water Control, Drum, Drum Rollers, Discharge, Boom, Boom Bucket, Supporting Frame, Operating Levers, Engine, Gears, Shafts, Clutches, Main Frame, Crawler, Crawler Drive, Derrick, Distributing Chute and Calcium Chloride Attachment. Important parts are clearly shown in photographs, and pictures of the paver at work on specific jobs are shown, and names of the owners given. The book contains diagrams and specifications of the new Ransome 27-E, and one section is devoted to "Central Mixing Plants." If writing the manufacturer for a copy of this book, kindly give the name of our publication.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, gives a detailed description and price list of parts in all sizes of their cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating. It will cut a piece one inch long or more at any point without starting joints or otherwise disturbing the main, and will make a clean cut in a gas or water main in the trench. Write to the Tucker Company for literature and price list of the Anderson Pipe Cutting Tool. In writing, kindly give the name of our magazine.

Cast Iron Pipe.—James B. Clow & Sons, 201-299 North Talman Avenue, Chicago, with foundries at Coshocton, Ohio, Newcomerstown, Ohio, and Birmingham, Alabama, carry large stock of pipe at points where large supplies can be obtained on short notice. Wire or write them concerning your requirements, they will be glad to care for your needs without delay. Mention our magazine when writing this company.

Cast Iron Pipe.—The Central Foundry Company, manufacturers of cast iron pipe with offices located in the principal cities, will be pleased to have you call at the nearest office or write to the New York office, 420 Lexington Avenue, for complete information in regard to their product, an iron to iron joined pipe, allowing for expansion and contraction, vibration and uneven ground settlement. Used for water supply, fire protection and other service.

Hydrants and Valves.—The Mathews Fire Hydrants, built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia. If you will write to Mr. C. Becker of this company he will gladly send you full information about their sand-cast and "sand-spun" centrifugal cast iron pipe fittings, valves, boxes and hydrants. Please use the name of our magazine if writing.

Manhole and Catch Basin Covers.—Write to Wm. E. Dee Company, 30 North La Salle, Chicago, Ill., for particulars concerning the different types of manhole and catch basin covers. Prices will be included on request. If writing, kindly use the name of our magazine.

Chlorination.—Wallace & Tiernan, Newark, New Jersey, manufacturers of chlorine control apparatus will be pleased to send you full particulars in regard to the sterilization of water by their method, and to furnish you with record of cities where their apparatus is being used. If writing for information, we would like to have you mention our magazine.

Valves.—Golden-Anderson Valve Specialty Company located in the Fulton Building, Pittsburgh, have issued a descriptive and data catalog on their automatic valves for steam and water service. Full details are given on each page as to construction, operation variations together with cross-section drawings. Data required for ordering is made very clear. If you desire a copy of this catalog write to Mr. J. A. Voland of the Golden-Anderson Company mentioning the name of our magazine.

Francois Cementation Process.—The Dravo Contracting Co. have acquired the sole American rights to the Francois patents, and have a highly skilled staff who will be pleased to help you with your problems. This method of grouting covers chemical processes for a hundred and one different cases, the engineers of the Dravo Company are ready to help you solve your problems. Write to their company at Pittsburgh, Pa., mentioning our magazine.

Hydrants, Valves, etc.—Full particulars for supplies needed by water works and fire departments will be sent upon request by the Bourbon Copper & Brass Works Co., 618 E. Front St., Cincinnati, Ohio, manufacturers of fire hydrants, gate valves, and extension valve boxes. Write for their catalog, giving the name of our magazine.

Sewer Cleaning Machine.—W. H. Stewart, whose factory is at Walkerville, Ontario, has branches in St. Louis, Mo., Jacksonville, Fla., and Boston, Mass., so that his patrons on this side of the border may be served without paying duty. Literature describing his sewer and conduit rods will be furnished on request. Rods will be shipped on trial. If writing to Mr. Stewart for information concerning his equipment kindly mention our publication.

Zeolite.—"Softening Municipal Water Supplies by the Use of Zeolite" is the title of a bulletin issued by the Zeolite Chemical Company, 140 Cedar Street, New York City. This booklet describes Green Sand, a natural base exchange Zeolite Mineral, used for the purpose stated. Write to Mr. R. E. Wagner of the Zeolite Company for a copy of this bulletin. If writing, we would appreciate it if you would mention this magazine.

Western Hot Patch Plant.—A product of the Austin-Western Road Machinery Company, 400 North Michigan Avenue, Chicago, for keeping roads in repair winter and summer. Write to their Chicago office or any branch office for their Bulletin on Winter Repair Work for particulars concerning this equipment. We would appreciate it if you would mention our magazine.

Cast Iron Pipe.—The McWane Cast Iron Pipe Company of Birmingham, Alabama, will be pleased to send upon request, illustrated literature giving full information concerning their product, its cost, life and uses. The western branch of this organization is the Pacific States Cast Iron Pipe Company of Provo, Utah.

Aerator.—The Simplex Surface Aerator, an effective means of producing "activated Sludge," is fully described in Bulletin E-5-28, issued by the Simplex Ejector and Aerator Corporation. The Chicago address is 2528 W. Madison St., Chicago. If writing for literature, kindly mention our magazine.

Automatic Air-Lift. — The Sullivan Machinery Company, 130 South Michigan Avenue, Chicago, has a handbook on their automatic air lift, and special automatic control information of particular interest to water works superintendents. Their catalogs also describe air made wells, and contain a complete story of how a city elected a mayor on his promise to get them well water, and how his promise was kept by the use of this method. Kindly mention our publication when requesting catalogs.

Wrought Iron Pipe.—"The Installation Cost of Pipe" is the title of a Bulletin issued by the A. M. Byers Company, Pittsburgh, Pa., containing cost data and full particulars concerning

No Floats or Fixtures but Absolute Water Control

A constant water level can be automatically maintained in reservoirs, tanks and standpipes by the use of

GOLDEN-ANDERSON

Automatic Cushioned Controlling Altitude Valves

These valves are always cushioned in closing and opening. They are extensively used for automatically maintaining a uniform stage of water in reservoirs, tanks and standpipes. No valves inside. No floats or fixtures, inside or outside of tanks. No freezing troubles.

Three ways of closing these valves:

1st—Automatically, by Water.
2nd—By Electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON

Pat. Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal - to - metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON

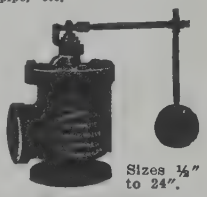
Pat. Automatic Cushioned Controlling Float Valves

1. Automatically maintain uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal - to - metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle or Globe, patterns to 24-in.

GOLDEN-ANDERSON

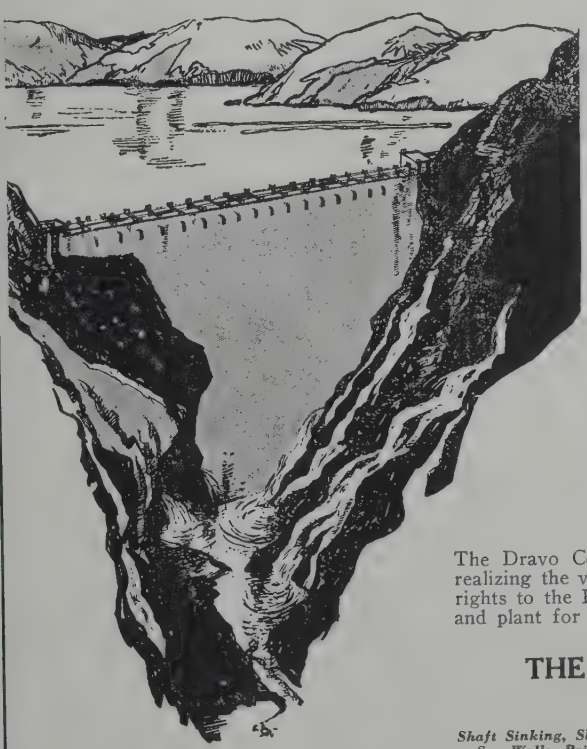
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal - to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.



Sizes ½" to 24".

Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.



Have You a Leakage Problem?

Francois Cementation Process

The surest and most economical method of overcoming difficulties due to the presence of water or bad ground.

The cementation process—the specialized high pressure injection of liquid cement mixtures into cavities, fissures, or cracks—has been developed to a high degree in Europe, and more particularly in Great Britain by the Francois Cementation Company, who have a long list of successful contracts to their credit, including internationally known structures.

Some features of the Francois Process are:

Grout is under perfect control;
Pressures to 3,000 pounds per square inch if required;
Chemical processes for a hundred and one different cases;
Wide experience in many years specialization.

The Dravo Contracting Company, after many years successful work and realizing the value of specialized grouting, have acquired the sole American rights to the Francois patents, and at their disposal is a highly skilled staff and plant for the execution of contracts.

THE DRAVO CONTRACTING COMPANY
PITTSBURGH, PA.

Shaft Sinking, Slopes, Tunnels, Pneumatic Caissons, Submarine Construction, Locks, Dams, Sea Walls, Bridge Piers, Steel Barges, Steel Towboats, Inland Waterway, Floating and Terminal Equipment, Steel Headframes, Steel and Concrete Tipples.

this product and its uses. Ask for Bulletin No. 38, giving the name of our magazine.

Trimo.—The trade name by which the wrenches manufactured by the Trimont Manufacturing Company, Inc., are known. These pipe wrenches are made with a braced frame to stand the hardest strain, with hard biting jaws that can be easily renewed, and the heat treated steel handles assure tremendous strength. Write for detailed information and prices to Roxbury (Boston), Mass., mentioning the name of this magazine.

Gate Valves.—The Darling Valve & Mfg. Company, with offices in New York, Chicago, Houston and Oklahoma City and headquarters in Williamsport, Pa., will be pleased to send you literature on the construction and operation of the Darling Gate Valves. If writing for particulars on this product, kindly mention our paper.

Deep Well Works.—The United Iron Works, Inc., of Springfield, Mo., with general offices in Kansas City, manufacturers of "Pomona" double stroke deep well power pumps, offer without obligation methods for economically solving pumping problems. The engineering experts will be pleased to advise with you. Descriptive catalogs will be sent upon request. If writing, kindly give the name of our magazine.

Pumps. — New Catalog containing complete information on centrifugal pumps, plunger pumps, and deep well power heads may now be obtained by writing the American Well Works, Aurora, Illinois. Their engineering department will be pleased to discuss your needs with you, recommending the best equipment for your purposes. Kindly use the name of our publication if writing for information.

Disposal Plants. — Fairbanks-Morse and Co., Chicago, or any of their branch offices in the principal cities will be pleased to furnish complete details concerning their F-M Trash pumps for handling unscreened sewage direct from sewers. Write for information, giving the name of our publication.

Cast Iron Pipe.—"The Two-Main System" is the title of a book which The Cast Iron Pipe Research Association is distributing free to city officials, engineers and taxpayers. It is a pocket size volume, written in non-technical style, with charts, drawings and photographs to make the telling more forceful. It explains how the two-main system is able to meet the demand of the taxpayer for a means of preventing the tearing up of costly streets for extensions, repairs, etc. A valuable book for public officials and engineers. Write to Mr. Thos. F. Wolfe, Research Engineer, Peoples Gas Bldg., The Cast Iron Pipe Research Association, Chicago, for a copy, kindly mentioning the name of our paper.

Clay Pipe.—The Clay Products Association, Conway Building, Chicago, makers of vitrified clay pipe, will be pleased to send you full information regarding this product.

Meters — Gauges — Valves. — Information on complete equipment for filtration plants may be secured by writing the Simplex Valve & Meter Company, 6749 Upland Street, Philadelphia, Pa. The Simplex Rate of Flow Controller is adaptable to large and small filter plants from 30-inch effuent to 3-inch. The Simplex Venture Type Meter indicates, records and totalizes the rate of flow, and the Simplex Filter Gauges may be had in many combinations of Indicating, Recording and Totalizing. If writing for particulars on this equipment, kindly mention our magazine.

Filtration Plants.—Norwood Engineering Company, Florence, Mass., will be pleased to send you full particulars regarding the Norwood Municipal Filtration Plants. Kindly give the name of our publication if requesting information.

Pipe Cutter.—Manufactured in two sizes for all types of pipe by the Ellis & Ford Mfg. Co., 18 Piquette Ave., Detroit, Mich. Circular giving full particulars will be sent by manufacturer upon request. We would appreciate it if you would mention our magazine, if writing.

Meter Boxes.—The Ford Meter Box Company of Wabash, Indiana, have a special bulletin on the Ford Type S Meter Boxes for "warmer climates." Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently handled.

Centrifugal Pumps. — Catalog-W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., gives methods of meeting water supply problems at the lowest cost. Full information regarding geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. If writing for a copy of this booklet, kindly give the name of our publication.

Centrifugal Pumps.—In order to be of assistance to users in choosing the right pump for their needs, Bulletin 1632-I has been issued by the Allis-Chalmers, Milwaukee, Wis. Types for steam turbine drive, motor drive or gasoline engine drive are described to best fit the purposes of installation. Write to Mr. H. G. Hoffman for copy of this bulletin.

Standard Construction Castings.—This is the title of a catalog which is attractive and different from the usual. It has just been issued by the Flockhart Foundry Company, 80 Polk Street, Newark, N. J. The booklet contains a Foreword explaining that the catalog is the result of a study, covering the past eight years, of the designs of castings used by governmental bodies, public utlities, etc., with a view to classifying and simplifying existing types, developing new types in some cases, but always seeking permanence and reasonable cost. The company was aided in this work by prominent engineers and State Highway Commissions, to whom they give credit. The table of contents itemizes twenty-three data sheets, each covering a separate type of casting. The data sheets then follow, each with sectional drawings, descriptions, with dimensions and code numbers for ordering. The Flockhart Company has had forty-eight years of experience in making castings for the construction field, and offers a free engineering service to their patrons in solving their problems. In addition to the products listed in the catalog, the company presents a list of products about which they will be pleased to send you detailed information. If writing for Standard Construction Castings ask for Catalog No. 101, which will be sent you without obligation. We would appreciate it if you would mention our magazine if writing manufacturer.

Chemicals.—A very complete and handsome book has just been issued by the LaMotte Chemical Products Company, McCormick Building, Baltimore, Md., called "The A B C of Hydrogen Ion Control." This is the fifth edition of this book, bearing the 1929 copyright of the company. It deals with the Colorimetric Method of determining hydrogen ion concentration and for water analysis, and serves as a text-book and guide to those just taking up the subject. It is written in terms readily understood by the non-technical reader. It also contains a complete line of materials and equipment for the analysis of water, sewage and industrial wastes. From the introduction through to the very end this will be found interesting and instructive reading. A Research Department is maintained by the company and it is always at the service of their patrons. A copy of "The A B C" will be sent you upon request, and we would appreciate it if you would mention our magazine if writing the manufacturer.

Tarvia.—A product for road construction, repair and maintenance manufactured by The Barrett Company, with offices in all the principal cities of the United States and Canada. Write to any of the branches of this company for help in solving your road problems.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.

ADVANTAGES OF PERMANENT PLANT FOR CONCRETE PIPE MANUFACTURE

No. 5 of Technical Series

Atlantic Cement Products, Inc.
Hicksville, Long Island, N. Y.

Improvement in quality will lead to increased use of concrete pipe

No loss of time because of bad weather will result in lower manufacturing costs with steady employment of labor and equipment. Accurate forecasts of production can be made. Being protected, equipment lasts longer. When under shelter and provided with comfortable and familiar conditions, workmen produce more. The smaller turn-over in labor favorably affects production.

With activities concentrated, closer supervision results. The superintendent can watch every step in the process of manufacture and prevent mistakes.

The Purchaser and his Engineer should satisfy themselves that the Pipe Manufacturer has modern equipment; employs modern methods; has proper facilities for making tests; and that an Inspector will easily be able to see what he should. The Manufacturer who has a modern permanent plant with easy access for inspection of process and product is naturally favored by Engineer and Purchaser.

The permanent concrete pipe plant produces a uniform product. It can run summer and winter—day and night if need be—and the product will not suffer in quality. The stock can be built up prior to heavy spring demand.

Discriminating Purchasers are paying more for centrifugally made concrete pipe. A fair investigation will prove the superiority of the

MOIR-BUCHANAN Centrifugal Process

For information concerning this process write to—

ASPHALTO-CONCRETE CORPORATION

1440 Broadway, New York City

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

SOS

This department is conducted by Station GCG (The Gillette Construction Group), but we need your help and cooperation. The more stories and items you send in to us, the more interesting will this section of our papers be to all our readers. Let us hear from you. Address The Editor, Distributor News, Gillette Publishing Company, 221 East 20th Street, Chicago.

Distributor Advertising Service Announced by Petroleum Heat and Power Company

An intensive advertising campaign has been planned by the Petroleum Heat & Power Co. of Stamford, Conn., to include newspapers, general and trade magazines, direct mail campaign, billboard and other features, which they expect to tie up directly with their distributors and dealers by means of a publicity service bureau.

The organization of this advertising and publicity service bureau for the benefit of the distributor is in the hands of Mr. J. R. Lunstead, formerly associated with the Radio Corporation of America. This direct tieup of the dealers' local advertising with national advertisements is an indication of the importance of the distributor in the sales promotional work.

There will be available for distributors and dealers, seasonal tie-up in newspaper ads for which either electros or complete matrices will be furnished, reprints of national advertisements, etc. This material will be distributed by the new service bureau, and the distributors will be informed on the latest methods of preparing and placing their local advertising, and in securing the best results from their efforts. The dealer is offered the personel service of the publicity bureau staff.

Feenaughty Machinery Represents Galion in Oregon, Washington and Idaho

Feenaughty Machinery Company, which was appointed several months ago as distributors in Oregon for the Galion Iron Works & Manufacturing Company, has now been given the Washington and Idaho territory as well. This announcement was made by the Pacific Coast representative of the Galion Company, Mr. Y. T. Leftwich. This change was made when the Jeffrey Manufacturing Company acquired control of the common stock of the Galion concern.

Butler Bin Make Several New Appointments

Fourteen new distributors have been appointed to handle the products of the Butler Bin Company of Waukesha, Wis., manufacturers of steel storage bins, weighing and measuring hoppers, bin gates, etc. The new representatives are: Arizona Road Machinery Co., Phoenix, Ariz.; General Equipment Mach. Co., Miami, Fla.; Hofius-Ferris Equip. Co., Spokane, Wash.; J. B. Harbison Equip. Co., Little Rock, Ark.; Loggers & Contractors Equip. Co., Portland, Ore.; Mechanical Supplies Co., Cincinnati, O.; W. T. McDonald & Co., Indianapolis, Ind.; New Mexico Road Machinery Co., Albuquerque, N. M.; Stannard-Arnold Co., Salt Lake City,

Annual Banquet of Associated General Contractors of America. Held at the Hotel Sherman, Chicago, Feb. 21, 1929

Suddenly, out of a spring sky . . .

An Advertisement of the
American Telephone and Telegraph Company

All was well on the telephone front on April 27, 1928. Suddenly, out of a spring sky, rain began to fall over central Pennsylvania. As night came on this turned into a furious storm of sleet, snow and wind. Inside of 48 hours, 3700 telephone poles were down. Seven thousand miles of wire tangled wreckage. Thirty-nine exchanges isolated. Eleven thousand telephones silent.

Repair crews were instantly mobilized and sent to the scene. From Philadelphia 47 crews came. Other parts of Pennsylvania sent 13. New Jersey, 6. New York, 4. Ohio, 6. Maryland and West Virginia, 12. In record time, 1000 men were stringing insulated wire and temporary cables along the highways, on fences and on the ground.

Within 72 hours the isolated exchanges were connected and the 11,000 telephones back in service. Then, while the temporary construction carried on, neighboring Bell System warehouses poured out all needed equipment, new poles were set, new crossarms placed and new wire and cable run.

In any crisis there are no state lines in the Bell System. In all emergencies of flood or storm, as well as in the daily tasks of extending and maintaining the nation-wide network, is seen the wisdom of One Policy, One System, Universal Service. Better and better telephone service at the lowest cost is the goal of the Bell System. Present improvements constantly going into effect are but the foundation for the greater service of the future.

"The Telephone Books are the Directory of the Nation"

Utah; J. C. Sheehan & Co., El Paso, Tex.; Tri-State Equipment Co., Memphis, Tenn.; Taylor Tractor Co., Columbus, O.; Geo. V. Treen & Co., Charleston, W. Va.; Wiley Bros., Inc., Oklahoma City, Okla.

Link-Belt Elects Watson Vice-President

James S. Watson, a Philadelphia youth thirty-four years ago, entered the local plant of the Link-Belt Company. Announcement has just been made of his election to the vice-presidency of the company. His headquarters will be at the Dodge works in Indianapolis.

After Mr. Watson had been with the company about eight years, gaining experience in various departments, he was chosen to take charge of the exploita-

James S. Watson

tion of Link-Belt silent chain as a power transmitting medium. This was in January, 1903, when silent chain was new, having been introduced in 1900. Since then Mr. Watson has become well known throughout the country as the head of the drive chain division of his company.

For the past nine years he has been located at the company's Dodge Works in Indianapolis, where as general manager, he has been in charge of production and sales of Link-Belt silent and roller chain drives, as well as Herringbone speed reducers through a band of power transmission engineers located in all the principal cities.

With this item we present a picture of the outward and visible Mr. Watson, but for knowledge of the man himself, we quote his business ideals:

"A definite knowledge of one's product; faith in one's self; belief in one's business associates; respect for one's competitors; and a general adherence to the Golden Rule."

Portland Cement Association Appoints New Southwestern Manager

Mr. Charles A. Clark, formerly district engineer in Dallas, Texas, for the Portland Cement Association, has been appointed manager of the Southwestern offices of the company, with headquarters at Kansas City, according to announcement of Mr. William M. Kinney, general manager of the association.

Mr. Clark is an alumnus of the University of Missouri, and during the past twenty years has been associated with several important engineering projects. On the Florida East Coast Railway from mainland to Key West, he acted as concrete inspector, and later was active in the development of Illinois' model highway system.

In 1917, Mr. Clark joined the staff of the Portland Cement Association as a fieldman for Missouri and Oklahoma. After a period of administrative work in the Chicago general office, he was assigned to Dallas as district engineer. From his Kansas City office, he will have supervision over Texas, Oklahoma, Kansas, Nebraska and Western Missouri. Mr. Clark is to succeed Mr. Forest Kaufman, resigned.

Many New Distributors to Handle REX Equipment

The Chain Belt Company has just appointed fourteen new distributors in almost as many states, to handle their line of REX equipment, including mixers, pavers, pumps, saw rigs, plaster and mortar mixers. The recent appointments are: The G. C. Phillips Tractor Co., Birmingham, Ala.; McGowin-Lyons Hardware & Supply Co.; Mobile, Ala.; Burnite Machinery Company, Denver, Colo.; Fuchs Equipment Company, Omaha, Neb.; Gierke-Robinson Co., Davenport, Ia.; Sheehan & Company, El Paso, Tex.; The Arizona Road Machinery Co. (branch of Sheehan), Phoenix, Ariz.; The New Mexico Road Machinery Co. (branch of Sheehan), Albuquerque, N. M.; Youngstown Mill Supply Company, Youngstown, O.; The LaLance Equipment Co., Huntington, W. Va.; McNeilly Machinery Company, Columbus, O.; Earnest Brothers, Norfolk, Va.; The Clyde Company, New Orleans, La.; Stannard-Arnold Machinery Co., Salt Lake City, Utah.

Huebotter Joins Waukesha Engineering Staff

Mr. H. A. Huebotter, well known to automotive and Diesel engineers, has recently joined the technical staff of the Waukesha Motor Company, Waukesha, Wis. He comes to the Waukesha Motor Company from the Butler Manufacturing Company, Indianapolis, Ind., where he was chief engineer.

Mr. Huebotter has been engaged in both practical and theoretical research for a number of years. From the time of his graduation from Purdue University in 1912, he has devoted his energies to automotive research, design and production. Extensive opportunities for research were available to Mr. Huebotter, when for several years at Purdue, he conducted classroom instruction, and worked out various experimental problems.

He is a member of the Society of Automotive Engineers, and is the author of the book "Mechanics of the Gasoline Engine."

M. B. Rider Joins H. O. Penn Mach. Company

Mr. M. B. Rider, formerly New York sales manager for the T. L. Smith Company, has joined the H. O. Penn Machinery Company as sales manager of the road building equipment division. Mr. Rider is well known in the east because of his long experience with road building equipment and the construction industry in general.

The H. O. Penn Machinery Company represent a number of prominent manufacturers of construction equipment, and Mr. Rider will handle the sales of all road construction equipment. Among the manufacturers whose products he will sell are Chain Belt Company and Butler Bin Company.

Atlanta Branch Opened by J. D. Adams Company

A new branch office and warehouse has been opened in Atlanta by J. D. Adams Company to serve their Georgia trade.

For a number of years the Adams adjustable leaning wheel graders and other road equipment have been sold by distributors in Georgia. This equipment is now being sold and serviced by the Atlanta branch.

Business Outlook in Maryland Good

J. J. Smith, 3620 Ednor Road, Baltimore, recently appointed representative for the Chicago Pump Company, reports that the outlook for business in Maryland and the District of Columbia for lines handled by him is unusually good.

In addition to a complete line of electrically-driven pumping machinery, Mr. Smith handles cast iron boilers, steel boilers of high and low pressure, ventilating equipment and hot water storage heaters.

Recent Appointments

The Chicago Pump Company have recently added to their list of representatives the following: Mr. Bernhard E. Hovind, 326 Jay St., La Crosse, Wis., and S. T. Weaver Company, 1002 N. Clinch St., Knoxville, Tenn.

Not in the bag

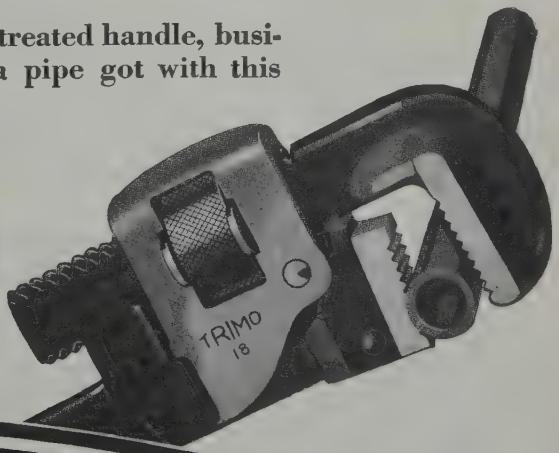
ANDREW J. PIPE emphatically denies the rumor that his recent disastrous contest with a Trimo pipe wrench was "in the bag."

"I know that I made a miserable showing, but I want all pipe lovers to know that I did my best.

"This new Trimo has a vicious grip and an ugly disposition. In fact it makes me feel a little shaky just to think about it."

The day when a stubborn pipe or nut could put up a winning fight is gone now. Trimo, Improved and Mightier, makes 'em all say "uncle."

Look over the rugged frame, heat treated handle, business-like jaws—what chance has a pipe got with this *all steel wrench?*



TRIMO

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON), MASS.

IMPROVED and MIGHTIER

Pipe Wrench

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Executive with 20 years' experience in selling contractors' and builders' machinery and equipment, is starting new organization and would like to hear from manufacturers desiring representation in Northern California.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Representatives Wanted

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Charles Edison Heads Splitdorf Companies

Charles Edison, son of the famous inventor, Thomas A. Edison, and one of the younger outstanding figures in the industrial life of the country, is the new president of the Splitdorf-Bethlehem Electrical Company and the Splitdorf Electrical Company.

The Splitdorf Electrical Company, well known as manufacturers of magnetos, spark plugs and other ignition devices, has for several months been making parts for the Edison Radio. The assembling of chassis for the Edison Radio has now been concentrated in the Splitdorf Radio Corporation, of

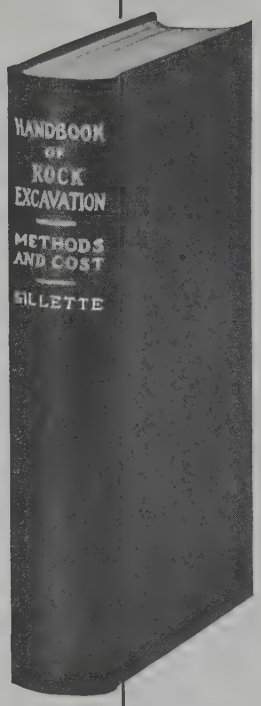
Charles Edison

which Mr. Edison is also the president, thus leaving the Splitdorf Electrical Company free to continue in its research and development in the ignition field.

Associated with Mr. Edison in the management of the Splitdorf Companies are executives who have had long, wide and varied experience in the Edison industries. Among them are: L. W. McChesney, vice-president and general manager; R. H. Allen, vice-president in charge of finance; H. F. Miller, treasurer; Howard H. Eckert, secretary, and Henry Lanahan, general counsel. Other announcements as a result of the reorganization of the affairs of the companies are L. S. Dunham, chief engineer; H. E. Krause, works engineer, both located at Newark, N. J.; and W. L. Kaiser as central district manager, with headquarters at Chicago.

J. L. Hart Machinery Company formerly known as the Coulter-Hart Equipment Company of Tampa, Fla. will represent George Haiss Mfg. Co., Inc., of New York, in the northern and eastern part of Florida.

WHO PAYS for Over-Breakage ?



Ever find yourself losing on the removal of rock slips or falls not included within the definite "neat lines" specified and shown in the blue prints? H. P. Gillette's "Handbook of Rock Excavation" (on page 15) points out this pitfall in which many a contractor has dropped a good share of his profits. You are told how to guard against it.

This is only one helpful point of the thousands contained in the Handbook. Much more valuable are those that go beyond the prevention of loss and show new ways to increase profits. All in all, there is a wealth of useful information that belongs at the elbow of the man who has a rock job on hand or ahead of him.

Our offer gives you the opportunity to examine every detail of this standard book for ten days. Read the coupon, fill in and mail.

Gillette Publishing Co., Chicago, Ill.

H. P. Gillette's "Handbook of ROCK EXCAVATION"

Borrow This Book

Send the Coupon

Here are the Subjects Exhaustively Covered in the following Chapters:

Preliminary Drainage Surveys, Design of the Drains, Drill Bits, Shape, Sharpening and Tempering, Machine Drills and Their Use, Cost of Machine Drilling, Steam, Compressed Air and Other Power Plants, Cable Drills, Well Drills, Augers and Cost Data, Core Drills, Explosives, Charging and Firing, Methods of Blasting, Loading and Transporting Rock, Quarrying Dimension Stone, Open Cut Excavation in Quarries, Pits and Mines, Railroad Rock Excavation and Boulder Blasting, Canal Excavation, Trench Work, Subaqueous Rock Excavation.

Gillette Publishing Company
221 E. 20th St., Chicago, Ill.

Please send me postpaid for free examination the "Handbook of Rock Excavation." In 10 days I agree to return the book or remit $6 in full payment and keep the book for my further profitable use.

Name.....

Company.....

Address.....

City and State..... WW-4-29

Akers of McWane Co. Joins Cox Agency

Mr. Arthur K. Akers of Birmingham, Ala., is rapidly becoming known as a writer of fiction, but as a writer of autobiography we were able to secure but little from him. Mr. Akers has so many friends in the water works field we take pleasure in presenting his picture and in giving the reason for his recent change in business connections.

As publicity manager for the McWane Cast Iron Pipe Company, Arthur K. Akers entered the advertising field in 1922. This business grew rapidly until in 1929 it ranks with the larger producers of cast iron pipe in America.

Arthur K. Akers

It has new foundries in Birmingham and Provo, Utah, the latter operating as the Pacific States Cast Iron Pipe Company, and serving the eleven western states. The McWane companies have always been liberal users of trade journal space.

In 1925 Mr. Akers began contributing short stories to the magazines, principally to RED BOOK. His stories of negro life in Alabama have since become one of the features of that magazine, one of them appearing practically every month over the past two years.

Other magazines have since begun requesting material from him to the point where the double load of full-time advertising work and a heavy fiction output has become such a burden that Mr. Akers has been forced to make a change in his arrangements.

Under the new plan, he will devote himself more largely to fiction writing, but has associated himself with the Cox Advertising Agency, of Birmingham, where he will continue to create and place the McWane Cast Iron Pipe Company and Pacific States Cast Iron Pipe Company publicity, as well as have oversight of that agency's other new industrial accounts.

Mr. Akers expresses the hope that he may continue his attendance at the water works and gas association annual conventions where he has been a familiar figure in connection with the exhibits of the McWane companies for the past seven years.

We are very happy that Mr. Akers' services are still to be available in the field of industrial advertising, and feel sure that the circulation of RED BOOK will show a marked increase in readers from the water works field.

Chain Belt Appoints New Advertising Manager Trade Publications

Mr. R. A. Shilbauer, who joined the Chain Belt Company of Milwaukee in 1920 as a rate-setter (and worked in that capacity in the various departments of the company's Grey Iron Foundry and Chain assembly plants on Park street and later became assistant advertising manager, has now been made advertising manager. He has been connected with the advertising department since 1925.

The Chain Belt Company manufactures engineering and conveying equipment, chain, transmission, concrete mixers and pavers, which are recognized under the trade name "Rex." The company also operates a plant in Cleveland, Ohio, under the name of the Stearns Conveyor Company, where belt conveyors and bulk material storage systems are made. The Chain Belt Company is a part of an affiliated group of companies consisting of the Sivyer Steel Casting Company, Federal Malleable Company and Interstate Drop Forge Company, all of Milwaukee.

Distributor Notes from Barber-Greene

An office has been opened at 527-528 Merchants National Bank Bldg., Cedar Rapids, Ia., by the Barber-Greene Company of Aurora, Ill., manufacturers of ditchers, loaders, conveyors, coal equipment, etc. Mr. Jack Marson of the Barber-Greene Company will have supervision of this office. Mr. Marson has been with the Barber-Greene Company for a number of years.

Another branch office under the supervision of Mr. Marson has been opened at 1106 Nicholas St., Omaha, Neb. Mr. W. E. Toole is in direct charge of this office.

W. S. Dickey Clay Mfg. Co. has consolidated the Atlanta and Birmingham offices, and mail should hereafter be addressed to P. O. Box 1592, Birmingham, Ala.

Whitcomb-Baldwin Combine Forces

The George D. Whitcomb Company, an organization engaged for the past fifty years in developing a complete line of gasoline, oil and alcohol burning locomotives for railway, industrial and contracting activities, and the Baldwin Locomotive Works of Philadelphia, known as one of the largest steam locomotive builders in the world, have combined forces to the extent that a substantial interest in the Whitcomb Company has been purchased by the Baldwin Company.

There is an ever increasing demand for internal combustion engines for the larger locomotives. The George D. Whitcomb Company is now building straight gear driven machines powered by gasoline, distillate and oil in sizes up to fifty tons, developing draw bar pulls in low gear, up to 25,000 lb. They have developed gas and oil electric locomotives up to 100-ton sizes and can furnish railway locomotives with a maximum draw bar pull of 50,000 lb.

The Baldwin Company will handle the products of the Whitcomb Company through its foreign representatives in all parts of the world, and through its domestic offices will handle the railway field in the United States.

The combination of the two corporations places them in a position to build every size of steam, gasoline, alcohol, distillate, Diesel, gas-electric or Diesel electric locomotive. The works of the Geo. D. Whitcomb Company are located at Rochelle, Ill.

1929 Ushers in New Engines and New Plant of Waukesha Motors

The new engines and power units developed during 1929 by the Waukesha Motor Company, Waukesha, Wis., will receive adequate service by reason of the new buildings now placed in operation for the benefit of users of the Waukesha products.

Quoting from a statement of the president of the company, Mr. H. L. Horning: "New plant extensions increase our floor area 100 per cent and give additional production facilities for both our new engines and those which we have been building for some years past. Proving laboratories for both research and production engines are now starting operation. * * * Greater stocks and prompter shipments are assured by our new buildings."

Sales offices and representatives for the Waukesha Company are located in New York, San Francisco, Tulsa, Oklahoma and Houston, Texas.

Vitrified clay sewer pipe has no upkeep because it stays down

CLAY PRODUCTS ASSOCIATION
CONWAY BUILDING
Chicago

VITRIFIED Salt Glazed CLAY
Sanitary Sewer Pipe

MN&WW 4-Gray

Sullivan Spader Wins in "Blindfold Test"

Hoag and Rollins were tunneling in hard clay at Toledo. They knew air clay diggers could beat hand labor. They didn't know which diggers were speediest.

So they tried a "blindfold test." Four men in the heading got four different clay spades. Clay spattered over the names. The men exchanged tools. When the shift came out of the hole—the superintendent asked which spade they wanted.

All voted for the same tool. The superintendent scraped off the clay and recorded the name, "SULLIVAN." After one week of testing, the contractors standardized on Sullivan Spaders.

Sullivan Spaders are hard on clay, but easy on men. They are balanced, smooth-running, and powerful. They will save you money.

Send for Catalog 6081-N.

Sullivan Air Equipment for the Water Works Department

Equipment for the Water Works Department includes Sullivan Portable Air Compressors, Rock Drills, Concrete Breakers, Clay Spaders, and Portable Hoists—in addition to Air Lift Pumping Systems. *Catalog on request.*

SULLIVAN
MACHINERY COMPANY
130 S. Michigan Ave.
After May 1st, 418 N. Michigan Ave.
CHICAGO

© Sullivan Mchry. Co.

SULLIVAN TRADE MARK

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Pull-Shovel.—Koehring Company, Milwaukee, Wis., has just issued a very attractive broadside descriptive of the Koehring Pull-Shovel. The pull-shovel boom, instead of being hinged to the turntable casting, is hinged to a separate casting which forms the base of the jib frame. It is built in two sizes and three models; ⅞ and 1¼ cu. yd. dippers, line-of-plate struck measure. In actual operation, heap loads of 1⅛ and 1⅝ cu. yd. can be handled. Many outstanding desirable features are pointed out in this bulletin, which also gives working dimensions and specifications. Write to the manufacturer for a copy, using the name of our publication.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Sani-Dri.—For all types of municipal buildings, schools and recreational centers having swimming pools, the Chicago Hardware Foundry Co. (Electrical Division), North Chicago, Ill., will be pleased to furnish complete information concerning the installation of Sani-Dri the modern, sanitary method of hair drying to prevent illness and relieve congestion in the shower rooms. Kindly give the name of our publication if writing for information.

Fiber for Sweepers.—The Huntsville Fiber & Veneer Works, Huntsville, Ala., will be pleased to send you a copy of their attractive booklet "The Story of Huntsville Hickory." This booklet gives the complete history of the growing of hickory and manufacturing process of turning it into the "Faultless Hickory Fibers" for long-life street sweepers. It contains much interesting information concerning fiber equipment, as well as about the service this company is able to render. If writing manufacturer, kindly give the name of our magazine.

Air Pump.—The Indiana Air Pump Company, Indianapolis, Ind., will be pleased to send you information concerning the air lift method of pumping wells. The catalog issued by this company stresses the dependability of this method with low depreciation and repairs. They will be pleased to send you catalog or to make quotations if you send them data and water requirements.

Paving Survey & General Highway Conditions.—To obtain an up-to-date picture of the present status of the highway business, the National Paving Brick Manufacturers Association appointed a committee of engineers to investigate the general economic status of the urban and rural highway conditions of the country. The result of this investigation is now presented as a report and may be secured by writing the association, 1245 National Press Bldg., Washington, D. C. William H. Connell was chairman of the engineering commission conducting the investigation. The report is well indexed and lists a wide range of topics such as: Highway expenditures; Highway cash dividends; Administration of the highway business; Planning highway systems; Signals; Trend in construction; Traffic and maintenance data; and an exhaustive study of the value of vitrified brick pavements. An informative and interesting book. If writing National Paving Brick Manufacturers Association for copy, kindly give the name of our publication. Ask for "Report of Investigations of Paving and General Highway Conditions."

Cement Lined Pipe.—The American Cast Iron Pipe Co., Birmingham, Ala., issued a book called "Cement-lined Cast Iron Pipe," describing the method of placing thin lining of cement in standard cast iron pipe to prevent tuberculation and reduce friction loss. If requesting copy of this book, please mention our magazine.

Centrifugal Pumps.—For a complete catalog on this equipment write to the DeLaval Steam Turbine Co., Trenton, N. J., asking for Catalog B. This is a very handsome 72-page catalog, discussing single stage and multistage pumps, for general water service, power plant service, including boiler feeding, condenser circulating and hot-well service, water works service, including main pumping units and booster, filtration and flushing service. Pumps for sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. The catalog is beautifully illustrated and gives cross sectional drawings showing details of pumps. There is a section on manufacturing methods and materials, and one on testing, also just what information should be furnished in seeking plant for individual requirements. Manufacturer will be pleased to send you a copy of this informative book. Kindly mention our magazine.

Forged Steel Gate Valves.—A very handsomely bound book is catalog No. 10, issued by the Darling Valve & Mfg. Co., Williamsport, Pa., containing 32 pages filled with illustrations and giving prices and specifications of this product. Each valve is given a rigid test before leaving the factory and is subjected to hydraulic pressure equal to its rated tested pressure. If valves of standard dimensions and design cannot be used, company will be pleased to be consulted concerning deviations. If writing manufacturer, give the name of our publication, please.

Cast Iron Pipe.—For complete information on McWane Cast Iron Pipe, "what it is," "what it does," fields it serves, types, specifications, quality, special features, etc., are all told in a 54-page booklet issued by the McWane Cast Iron Pipe Co., Birmingham, Ala. The territory west of the Rocky Mountains is served by the plant at Provo, Utah, called the Pacific States Cast Iron Pipe Co., of which Mr. J. P. McWane is president. Write to the manufacturer for a copy of this booklet on McWane precalked joint cast iron pipe and fittings. Kindly mention the name of our paper.

Rawhide Packing.—Mabbs Hydraulic Packing Company, 431 S. Dearborn St., Chicago, will be pleased to send you information concerning sizes, weights and uses of their rawhide packing. This packing is practically anti-frictional, will not cut or score metal surfaces and never becomes hard or glazed. It works equally well on centrifugal or reciprocating pumps. This packing has been found of service for the marine business, in cotton gins, for mining purposes and in oil fields on pumps and wells. It is put up in standard tin pails of from 5 to 50 lb. and in kegs and barrels of 100 and 200 lb. This company makes a specialty of rawhide washers for packing the stems of water meters. They can be ordered by meter companies in 100,000 lots. Write the manufacturer for further information, kindly mentioning our magazine.

Fire Pumps.—Bulletin No. 104 has just been issued by the Chicago Pump Co., 2300 Wolfram St., Chicago, fully illustrating and describing their electric centifugal fire pumps. Booklet contains blue print drawings and a list of installations. If writing manufacturer for copy kindly mention our magazine.

Cast Iron Soil Pipe.—A very interesting booklet, containing twelve pages of beautiful modern buildings, has been

WATER WORKS

Detroit, Mich.
1,500,000 gallons

Elevated Tanks *for* Municipal Water Works

Pittsburgh-Des Moines steel tanks are especially designed for municipal water works, and have furnished water storage to many communities for over thirty years.

An elevated water storage tank takes care of the water consumption during the peak hours and insures a constant pressure at all times. It eliminates fire hazards when repairs are being made at the pumping plant.

We build complete water works system, including pipe lines, reservoirs and filtration and purification plants.

Ask for our Municipal Catalog No. 2

Pittsburgh-Des Moines Steel Company

4 Neville Island, Pittsburgh, Pa.

Des Moines — New York — Chicago
Atlanta — Dallas — Seattle — San Francisco

PITTSBURGH DES MOINES

Protect yourself!

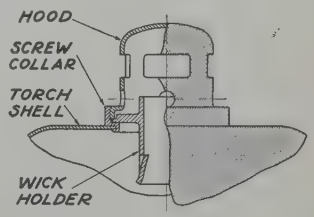
with simple and direct LIGHT

from a dependable source

in other words always use the

TOLEDO TORCH

PRETTY colored lanterns may get you by with cautious drivers, if you hire a watchman to keep them on the job. But it's the reckless ones who cause all the accidents. With them the use of uncertain signals, such as red lanterns, is a needless risk for you to take, especially when it is so much more costly than using TOLEDO TORCHES.



The New TOLEDO TORCH is dependable in all kinds of weather, is very economical in the use of fuel, and is never molested by petty thieves. The secret of its great success lies in the new ECONOMY BURNER. (Patents Pending)

IT is the only burner that will give you satisfactory service at all times. Observe carefully its construction, and *insist on having the genuine.* Similar looking imitations do not compare in performance.

Ask for the *'Champion'*

"the harder it blows the better it burns"

Made only by

THE TOLEDO PRESSED STEEL CO.
TOLEDO, O.

issued by The Soil Pipe Association, Birmingham, Ala. The booklet is an announcement of the willingness of this association to guarantee cast iron soil pipe for 100 years, or for the life of any building in which it is used. If writing the association for information concerning this proposition, kindly use the name of our publication.

"Water Services that Serve" is the title of a brochure just issued by the Copper and Brass Research Association for distribution to municipal authorities, engineers and contractors. The booklet gives general data on copper and brass tubing and pipe with special reference to copper for use in service pipe between water mains and house lines. Tensile strength, bursting pressure tests, sizes, lengths and general data about installation are included in tables and explanatory paragraphs. If writing the assocation for a copy of this booklet, kindly mention our magazine.

Boyer Riveting Hammers.—A very attractive bulletin, SP-1694, has just been received from the Chicago Pneumatic Tool Co., 6 E. 44th St., New York, covering in a very thorough manner this equipment. The booklet contains the announcement that after Feb. 1, 1929, all Boyer riveting hammers will be furnished with an improved hardened and ground valve unit, unless specifically ordered with the soft valve block. Write for a copy of the bulletin, kindly mentioning our magazine.

Pump Control.—Bulletin No. 140 has been issued by the Chicago Pump Co., 2300 Wolfram St., Chicago, listing complete pump control units for operating pumping plant. Control panels, control boards, float switches, automatic alternators, etc., are illustrated and described in this 12-page, loose leaf style bulletin. This will be an aid in selecting the proper pump control. . Manufacturer will be pleased to send you a copy, kindly give the name of our publication, if writing for copy.

Water Softeners and Purifiers.—The Graver Corporation, East Chicago, Ind., has issued a little booklet illustrating and describing the various types of water softeners and filters, as well as steel storage tanks. Hot process, cold process, zeolite and lime-zeolite treatment, for industrial plants, ice plants and railroads, as well as the smaller types for household purposes are described. More complete bulletins devoted to any special type are specified by letter. Filters for industrial and municipal works and swimming pools also receive attention. If requesting a copy of this booklet, kindly give the name of our magazine.

Dipper Trip.—A folder from the Morin Mfg. Co., 896 Main St., Holyoke, Mass., manufacturers of appliances and improvements, gives illustrations and detailed information about their Universal-Semi-Automatic Dipper Trip. This dipper trip may be adapted to any make or type of shovel, steam or air, gasoline, diesel, electric, or gas-electric and gas plus air. The outstanding features of this appliance set forth in circular are ease of operation and elimination of lost motion. Write for folder describing this equipment and also the friction-type dipper trip and tag line winder for gasoline, diesel and electric, and gas-electric and gas plus air shovels. If writing manufacturer kindly mention our magazine.

Paved Invert Culverts.—"Paving the Culvert to Combat Erosion" is the title of a comprehensive pamphlet issued by the Armco Culvert Mfrs. Association, Middletown, O. This product is designed for use where culverts carry highly sedimentary streams, on steep grades, in mountainous country, storm sewers, etc. The booklet illustrates in detail the paved invert and described tests applied in developing it. The culvert must be made to withstand hydraulic traffic within and vehicular traffic from above. The booklet described the Armco system. Kindly give the name of our publication if writing manufacturer for literature.

For Water Works Campaigns.—Of interest to city officials and water works engineers in promoting campaigns for securing water works or renewals is the booklet issued by the Cast Iron Pipe Publicity Bureau of the Cast Iron Pipe Research Association, 122 S. Michigan Ave., Chicago. It is called Community Advertising, and shows colored reproductions of posters, street banners, direct mail literature and newspaper advertising to be used in securing this type of improvements for the home town. This campaign material will be furnished free by the association to aid in the cause of water works. Write for a copy of Community Advertising and find out just how much free help is available in aiding you with your problems. Kindly mention the name of our publication when writing.

Automatic Valves.—Catalog No. 24 has been issued by the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., to present with illustrations and descriptions their well known automatic cushioned valves for steam and water service and to call attention to many new styles of valves. The catalog contains 200 pages, well printed on enamel paper, with a complete index. A very useful and attractive catalog on valves. The Pittsburgh address of the Golden-Anderson Specialty Co. is Fulton Building. Kindly mention our magazine, if writing.

Gasoline Hoists.—The American Hoist & Derrick Co., St. Paul, Minn., has just issued an eight-page folder concerning the "American" silent chain drive gasoline hoists for general hoisting work. The booklet gives specifications, outstanding features and construction details. The engine and hoisting drums are mounted on a cast iron frame insuring absolute alignment of all working parts. The unit is entirely self-contained.

Monarch Tractors.—Wise planning highway officials, who were snowed under during the past winter, will look to the snow removal machinery in time to have it on hand next year when the first snow flies. The Allis-Chalmers Mfg. Co., Milwaukee, Wis., will be pleased to send you literature concerning the outstanding features of the Monarch "75" with V-type plow for keeping the roads clear in the heaviest snows.

Expansion Joints.—Write to the Philip Carey Co., Lockland, Cincinnati, O., for full particulars concerning their Elastite Expansion Joint, which requires only ordinary tools and workmen for installation. If writing manufacturer for literature concerning this product, kindly mention our publication.

Snow Removal, 1929.—This is the title of a very attractive booklet which the Caterpillar Tractor Co., San Leandro, Calif., has issued looking forward to the work and equipment which will be needed for next winter to keep the roads clear. Removal in Cities; Cost of Removal; America's Snowbelt and Loss to Business are some of the topics treated. Equipment for meeting these problems is illustrated and described. Send for a copy of this booklet and plan to meet this situation before it becomes a problem. Kindly mention our magazine, if writing manufacturer.

Well Systems.—Write to Layne & Bowler, Inc., Memphis, Tenn., or any of their representatives located in all the principal cities, for information about the Layne Water Well Systems. They will be pleased to give you the benefit of their long years of experience in this field.

Leadite.—A self-caulking material for cast iron pipe manufactured by the Leadite Co., Land Title Bldg., Philadelphia, Pa. The manufacturer will be pleased to send you detailed information and records of pipe lines where this product was used. If writing, kindly give the name of our paper.

Sludge Removal.—The Link-Belt sludge collector is recommended by the manufacturer for its sturdy mechanism and reliability in removing sludge from sedimentation tank. An excess of accumulation of sludge will not slow down or stop operation. For complete information concerning this or other sewage treatment plant equipment, write to the Link-Belt Co., 300 W. Pershing Road, Chicago. Kindly mention our magazine.

Stops and Water Works Products.—For information on the full line of stops and other products for water works, write to the Mueller Co., Decatur, Ill., for catalog. They will be pleased to furnish information about water works companies using their curb stops and corporation stops for standard equipment.

GOLDEN-ANDERSON

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed-water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No. exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

Automatic "Cushioned" Controlling Altitude Valves

Cushion All Water Surges

Automatically maintain a constant stage of water in reservoirs, tanks and standpipes.

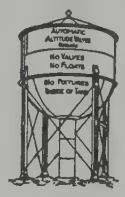
They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer.

There are no dangerous surges to burst water mains. **Write for details.**



REMEMBER
Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

Golden-Anderson Valve Specialty Co.
1385 Fulton Bldg., Pittsburgh, Pa

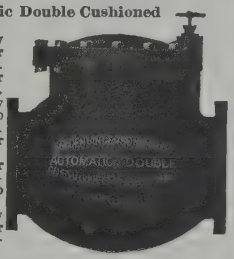
GOLDEN-ANDERSON
Patent Automatic Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves

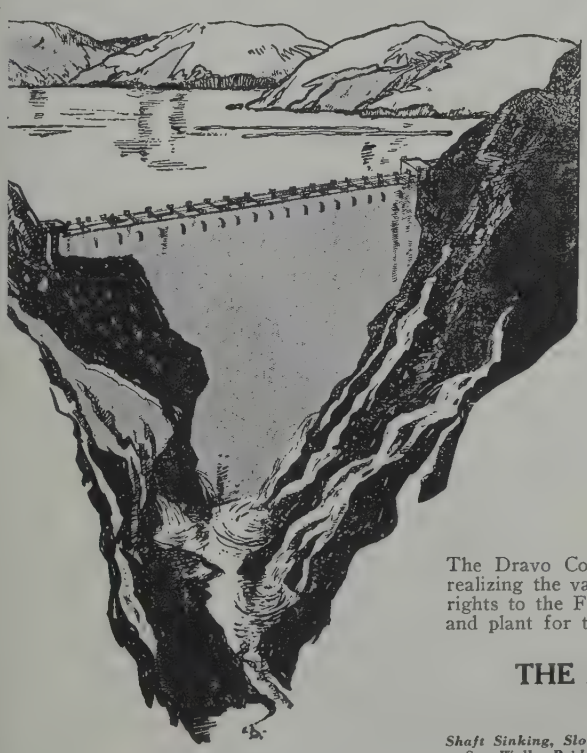


1. Especially adapted for Water-Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering. Hammering, or Sticking.
4. Globe or Angle Patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal - to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.

Sizes ½" to 24".



Have You a Leakage Problem?

Francois Cementation Process

The surest and most economical method of overcoming difficulties due to the presence of water or bad ground.

The cementation process—the specialized high pressure injection of liquid cement mixtures into cavities, fissures, or cracks—has been developed to a high degree in Europe, and more particularly in Great Britain by the Francois Cementation Company, who have a long list of successful contracts to their credit, including internationally known structures.

Some features of the Francois Process are:

Grout is under perfect control;
Pressures to 3,000 pounds per square inch if required;
Chemical processes for a hundred and one different cases;
Wide experience in many years specialization.

The Dravo Contracting Company, after many years successful work and realizing the value of specialized grouting, have acquired the sole American rights to the Francois patents, and at their disposal is a highly skilled staff and plant for the execution of contracts.

THE DRAVO CONTRACTING COMPANY
PITTSBURGH, PA.

Shaft Sinking, Slopes, Tunnels, Pneumatic Caissons, Submarine Construction, Locks, Dams, Sea Walls, Bridge Piers, Steel Barges, Steel Towboats, Inland Waterway, Floating and Terminal Equipment, Steel Headframes, Steel and Concrete Tipples.

Meter Repair.—For repairing or testing any make or size of water meter, write to the Reading Meter Repair Co., Inc., Reading, Pa., for prices and particulars. They will be pleased to furnish information concerning any hydraulic supplies and equipment.

Deep Well Power Pump.—The United Iron Works, Inc., Springfield or Kansas City, Mo., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems. If writing for literature, kindly mention our magazine.

Sanitary Specialties.—For information on a complete line of special sanitary products manufactured by the Servicised Products Corp., address the company at 6051 W. 65th St., Chicago. Among these products are bituminous rope, sewer compound, sewer belts, asphalt liner slabs, etc.

Road Oil.—Standard Road Oil is offered by the Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, for obtaining dustless dirt or gravel roads and giving a waterproof roadway. Write to the company for information on application.

Hydrants, Valves, Etc.—Write to the Columbian Iron Works, Chattanooga, Tenn., for descriptive literature of the Columbian Fire hydrants, Gate valves, Valve boxes, Hydrant extension sections, or other water works equipment. We would appreciate it if you would mention our publication if asking for information.

Cast Iron Pipe.—United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will be pleased to send you literature explaining the differences between the deLavaud Cast Iron Pipe and other types of pipe. This is a centrifugally cast pipe in which the graphite particles are finely divided and evenly spread.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, gives a detailed description and price list of parts in all sizes of their cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating. It will cut a piece one inch long or more at any point without starting joints or otherwise disturbing the main, and will make a clean cut in a gas or water main in the trench. Write to the Tucker Company for literature and price list of the Anderson Pipe Cutting Tool. In writing, kindly give the name of our magazine.

Wrought Iron Pipe.—"The Installation Cost of Pipe" is the title of a Bulletin issued by the A. M. Byers Company, Pittsburgh, Pa., containing cost data and full particulars concerning this product and its uses. Ask for Bulletin No. 38, giving the name of our magazine.

Compressors.—The Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, Ill., has issued a new handbook on Compressed Air Practice, containing numerous suggested uses for compressed air as an aid to speeding production and improving products. It also contains helpful information concerning piping, lubrication and the care of compressed air equipment. The manufacturer will be pleased to send a copy of this book upon request, and we would appreciate it if you would mention our publication if writing.

Automatic Control Valves.—The Ross Valve Mfg. Co., Inc., Archibald St., Troy, N. Y., will be pleased to furnish you with particulars regarding their automatic pressure control valves for feed water filters, portable fire hydrants, hydraulic engines, hydraulic booster pumps, etc. Write for information, giving the name of our publication.

Clay Pipe.—The Clay Products Association, Conway Building, Chicago, makers of vitrified clay pipe, will be pleased to send you full information regarding this product.

Meters — Gauges — Valves. — Information on complete equipment for filtration plants may be secured by writing the Simplex Valve & Meter Company, 6749 Upland Street, Philadelphia, Pa. The Simplex Rate of Flow Controller is adaptable to large and small filter plants from 30-inch effuent to 3-inch. The Simplex Venture Type Meter indicates, records and totalizes the rate of flow, and the Simplex Filter Gauges may be had in many combinations of Indicating, Recording and Totalizing. If writing for particulars on this equipment, kindly mention our nagazine.

Filtration Plants.—Norwood Engineering Company, Florence, Mass., will be pleased to send you full particulars regarding the Norwood Municipal Filtration Plants. Kindly give the name of our publication if requesting information.

Compressors, Drill Sharpeners, Pneumatic Tools.—The Sullivan Machinery Company, 122 South Michigan Avenue, Chicago, Ill., will be pleased to send you a copy of their new eight-page folder, Form 2007, calling special attention to their portable air compressors, mounted to suit your requirements; drills, spaders, hoists and sharpener—all illustrated and described. Catalogs will also be sent upon request, write for information. Kindly mention our magazine, if writing manufacturer,

Meter Boxes.—The Ford Meter Box Company of Wabash, Indiana, have a special bulletin on the Ford Type S Meter Boxes for "warmer climates." Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently handled.

Water Meters.—Write to the Badger Meter Manufacturing Company, Milwaukee, Wis., for detailed bulletin on their complete line of meters, ranging in size from the smallest disc to the 12-in. turbine. This information will point out the way to reduce your pumping costs, by the use of the Badger Turbine Meter at the pumping station and the meters on the service lines. Many changes were made during the past year to increase efficiency and serviceability. If writing for literature, kindly mention our magazine.

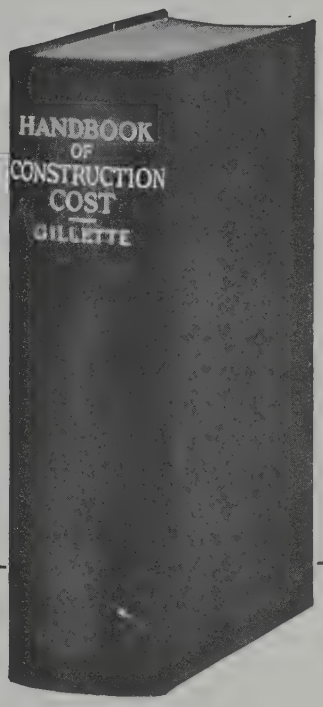
Excavator.—Write to the Bucyrus-Erie Company, South Milwaukee, Wis., or Erie, Pa., for bulletin on their D-2 Diesel Drag-Shovel. This shovel is built for the hardest work at a minimum cost. Easily convertible to clam-shell-crane, shovel or dragline. Manufacturer will be pleased to furnish you with performance records of this equipment.

Dosing Tank Counter, Sewage Tees, Nozzles, Etc.—Bulletin No. 100, issued by the Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, contains full descriptions, table of weights and price list of this equipment. The new dosing counter for checking the amount of sewage treated by keeping count of the number of times the dosing tanks have discharged may be mounted on the roof of the tank or attached by brackets to the side wall. The counter is protected by a weather-proof cover and has been operated in all kinds of weather. For complete information about the Marley Sewage Tees for sprinkling filter beds and nozzles of the threaded spindle type, lock spindle type and spindle and half spray plug, write to the manufacturer. If requesting literature on this equipment, we would appreciate it if you would mention our magazine. The New York office of this company is at 9 Park Place.

Industrial Engines.—Bulletin No. 201 has been issued by the Weber Engine Company, Kansas City, Mo. This is a horizontal, 2-cycle, single cylinder, medium compression engine, of comparatively light weight, designed and constructed to insure the greatest strength and rigidity. For users requiring power units of 30-hp., 40-hp., 60-hp., 80-hp., 100-hp. and 125-hp. it affords a thoroughly reliable, compact and economical oil or gas engine of great simplicity. This engine is adaptable for water, sand, drainage or irrigation pumps, electric generators, air compressors, rock crushers, pipe line machinery, mills and industrial plants. The bulletin contains illustrations and cross-sectional drawings and full description. Write for a copy of this bulletin, kindly mentioning our magazine.

What's the Last Step Before

"I Give Up" ?



In your experience did a particularly tough estimating problem ever have you on the verge of giving up? Whether you did or not you realize that "I give up" usually means the other fellow gets the job.

This book on Construction Costs was written to prevent most of those cases in which the contractor, estimator or engineer feels baffled. When you realize that you are never really stumped until after you have referred without success to Gillette's "Handbook of Construction Costs," you'll recognize the value of this book. Because you'll find in most cases that the Handbook quickly refreshes your mind or furnishes new information on every element of construction expense.

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Please send me postpaid for free examination the "Handbook of Construction." In 10 days I agree to return the book or remit $6 in full payment and keep the book for my further profitable use.

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Company.....

Address.....

City and State..... WW-4-29

Francois Cementation Process.—The Dravo Contracting Co. have acquired the sole American rights to the Francois patents, and have a highly skilled staff who will be pleased to help you with your problems. This method of grouting covers chemical processes for a hundred and one different cases, the engineers of the Dravo Company are ready to help you solve your problems. Write to their company at Pittsburgh, Pa., mentioning our magazine.

Hydrants, Valves, etc.—Full particulars for supplies needed by water works and fire departments will be sent upon request by the Bourbon Copper & Brass Works Co., 618 E. Front St., Cincinnati, Ohio, manufacturers of fire hydrants, gate valves, and extension valve boxes. Write for their catalog, giving the name of our magazine.

Sewer Cleaning Machine.—W. H. Stewart, whose factory is at Walkerville, Ontario, has branches in St. Louis, Mo., Jacksonville, Fla., and Boston, Mass., so that his patrons on this side of the border may be served without paying duty. Literature describing his sewer and conduit rods will be furnished on request. Rods will be shipped on trial. If writing to Mr. Stewart for information concerning his equipment kindly mention our publication.

Zeolite.—"Softening Municipal Water Supplies by the Use of Zeolite" is the title of a bulletin issued by the Zeolite Chemical Company, 140 Cedar Street, New York City. This booklet describes Green Sand, a natural base exchange Zeolite Mineral, used for the purpose stated. Write to Mr. R. E. Wagner of the Zeolite Company for a copy of this bulletin. If writing, we would appreciate it if you would mention this magazine.

Trimo.—The trade name by which the wrenches manufactured by the Trimont Manufacturing Company, Inc., are known. These pipe wrenches are made with a braced frame to stand the hardest strain, with hard biting jaws that can be easily renewed, and the heat treated steel handles assure tremendous strength. Write for detailed information and prices to Roxbury (Boston), Mass., mentioning the name of this magazine.

Hydrants and Valves.—The Mathews Fire Hydrants, built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia. If you will write to Mr. C. Becker of this company he will gladly send you full information about their sand-cast and "sand-spun" centrifugal cast iron pipe fittings, valves, boxes and hydrants. Please use the name of our magazine if writing.

Chemicals.—The Hooker Electrochemical Company of 25 Pine St., New York City, or Tacoma, Wash., will be pleased to send you literature concerning the Hooker chemicals. Among the products of this company are listed: Caustic Soda, Liquid Chlorine, Bleaching Powder, Muriatic Acid, Monochlorbenzine, Paradichlorbenzine, Benzoate of Soda, Benzoyl Chloride, Ferric Chloride, etc. Plants are located at Niagara Falls and Tacoma. If writing manufacture, kindly give the name of our paper.

Meter Boxes.—If you will write to H. W. Clark Company, Mattoon, Ill., they will be pleased to send you catalog No. 24, giving full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for access for repair work or replacements. If requesting copy of catalog, kindly mention our magazine.

Pumps. — New Catalog containing complete information on centrifugal pumps, plunger pumps, and deep well power heads may now be obtained by writing the American Well Works, Aurora, Illinois. Their engineering department will be pleased to discuss your needs with you, recommending the best equipment for your purposes. Kindly use the name of our publication if writing for information.

Disposal Plants. — Fairbanks-Morse and Co., Chicago, or any of their branch offices in the principal cities will be pleased to furnish complete details concerning their F-M Trash pumps for handling unscreened sewage direct from sewers. Write for information, giving the name of our publication.

Cast Iron Pipe.—National Cast Iron Pipe Company, Birmingham, Ala., will be pleased to send you particulars in regard to cast iron pipe for water and gas. Pipe made by sand cast and deLavaud centrifugal processes, also fittings and 2-in. cast iron service pipe. Branches in the principal cities.

Filtration Plants.—The Norwood Engineering Company, Florence, Mass., has much information on the installation of filtration plants which they would be pleased to send you if interested in municipal plants. Write for records of Norwood Municipal Filtration Plants. Kindly mention our magazine.

Reinforced Concrete Pipe.—The Lock Joint Pipe Company, Ampere, N. J., would be pleased to send you full particulars concerning Lock Joint Reinforced Pressure Pipe; its permanence, high carrying capacity, tightness, expansion joints, etc.

Sluice Gates.—Coldwell-Wilcox Company, South Water St., Newburg, N. Y., manufacturers of sluice gates, sheer, flap and butterfly valves, flexible joints, etc., will be pleased to send you full information concerning any of these products. If writing for catalog, kindly mention our paper.

Concrete Pipe.—Write to the Asphalto-Concrete Corporation, 1440 Broadway, New York City, for full information and manufacturing rights for the use of the Moir-Buchanan Centrifugal Process of making concrete pipe. Low manufacturing costs, low laying costs, high density, low absorption and long pipe life are features of this product.

Chlorinator.—The Paradon Manufacturing Company, Arlington, N. J., has issued Bulletin W-22, describing in detail the Paradon Chlorinators for city and private water and sewage systems, industrial plants and swimming pools. If writing for a copy of this bulletin, we would appreciate it if you would mention our magazine.

Gas Main Stopper.—The Safety Gas Main Stopper Co., 523 Atlantic Ave., Brooklyn, N. Y., will be pleased to furnish you with particulars on the use of the Goodman Cylindrical Stopper, to stop the flow in sewers. Write for information, giving the name of our publication.

Filter Sands and Gravel.—To meet the most rigid specifiactions on this product write to the Northern Gravel Company, Muscatine, Ia., for information on their "Standard."

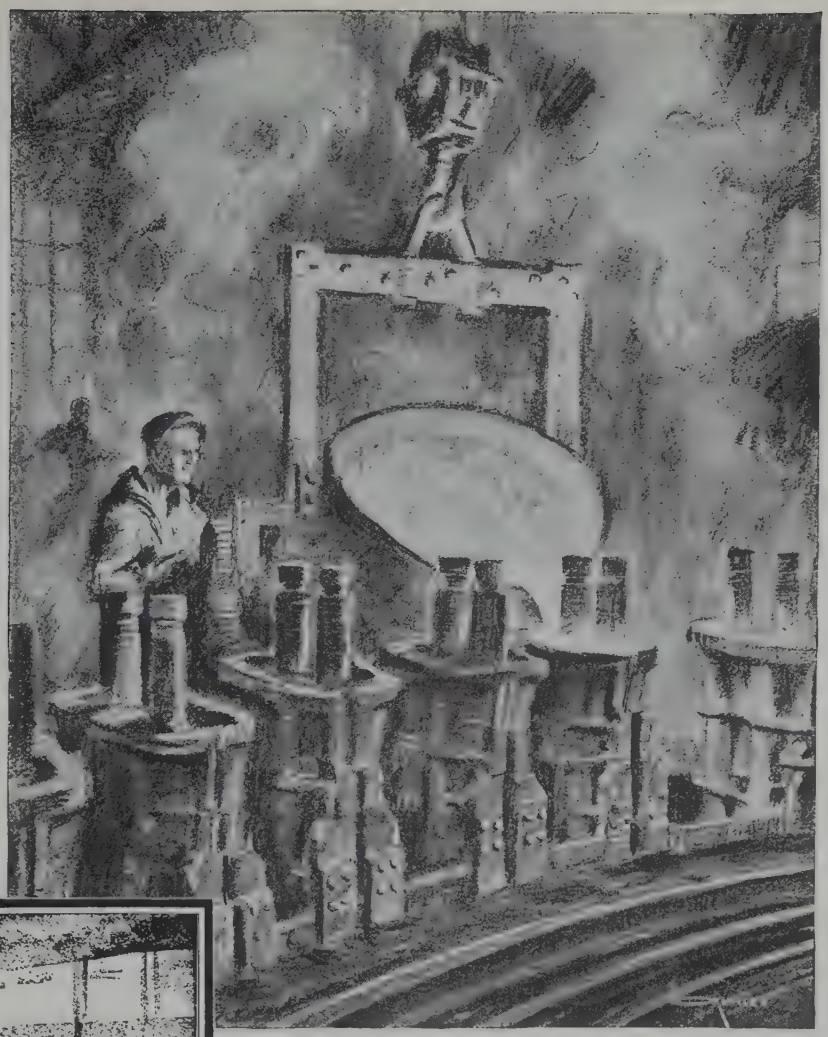
Castings.—Write to the South Bend Foundry Company, South Bend, Ind., for information concerning their patented chilled manhole covers. Information furnished on all kinds of gray iron castings.

Valve Housings.—S. E. T. Valve & Hydrant Company, 50 Church St., New York City, will be pleased to send, upon request, descriptive literature on their cast iron sectional valve housings, built in different sizes and depths. This company makes a complete line of municipal street castings and will furnish catalog if desired.

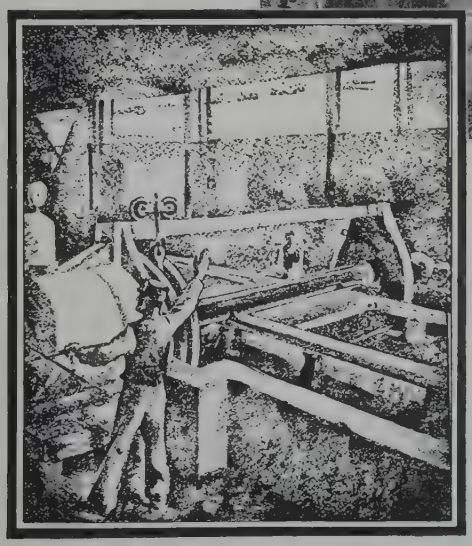
"The Cleaning of Water Mains."—This is the title of a booklet issued by the National Water Main Cleaning Company, 32 Church St., New York, describing the method so successfully used by them for the past twenty years. Write for a copy, giving the name of our magazine.

Chlorination.—Wallace & Tiernan, Newark, New Jersey, manufacturers of chlorine control apparatus will be pleased to send you full particulars in regard to the sterilization of water by their method, and to furnish you with record of cities where their apparatus is being used. If writing for information, we would like to have you mention our magazine.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.



Every length of cast iron pipe must pass a severe hydrostatic test as shown below. The pipes are brought into a testing press, sealed at each end and pumped full of water at a pressure as high as 300 lbs. per sq. inch according to the size of pipe.



NOWHERE is scientific control more in evidence than in the foundries of modern cast iron pipe manufacturers. Today, for example, the percentages of carbon and phosphorus necessary to produce greatest strength are known and accurately controlled. Today, the pouring and cooling rates of cast iron pipe are checked with extreme care, and the thickness and diameter of every pipe are tested with precision instruments. It is a noteworthy fact that the manufacture of cast iron pipe today claims a leading place in the ranks of *modern* American industry.

* * *

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and proper use of Cast Iron Pipe. Pipe bearing the Association "Q-check" mark may be obtained from the following: American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Cast Iron Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

CAST Q IRON

The "Q-check" symbol shown above has been adopted as the trade mark of The Cast Iron Pipe Research Association. Insist on this "Q-check" mark when specifying cast iron pipe for gas, water, sewer, or industrial service.

For complete information write to The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, Peoples Gas Building, Chicago.

CAST IRON PIPE

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Kalbfleisch Corporation Celebrates Century in Chemical Industry

In March the entire organization of the Kalbfleisch Corporation of New York city, together with a few invited guests, gathered at the Fifth Avenue Restaurant to enjoy the company's century dinner and to do honor and tribute to the house of Kalbfleisch.

Mr. Hays H. Clemens, a director of the company, served as toastmaster. Mr. A. B. Savage, vice-president and treasurer outlined the development of the company, James W. Prendergast, general counsel, described operations at the various plants, six in number, stretching from Connecticut to Louisiana, and Mr. Harry L. Derby, president and chairman of the board, visioned the future of the corporation.

Mr. R. A. Asbury, plant manager at Erie, Pa., in behalf of the directors, officers and employees, presented an inscribed silver platter to Mr. Derby.

Kalbfleisch Corporation was founded in 1829 by Martin Kalbfleisch. His son Franklin H. was serving as president at the time of the late war, when he resigned in favor of Mr. Harry L. Derby who has held the office since that time. A message was read from Miss Augusta S. Kalbfleisch paying tribute to the founders of the organization and the present management and expressing the hope that in the future, as in the past, the corporation will stand always for the best.

Novo Engine Company Appoints Many New Distributors

The Novo Engine Company of Lansing, Michigan, manufacturers of hoists, drag lines, engines, pumps, lighting units and similar equipment announce the recent appointment of the following distributors to handle their products: Jersey Contractors Equipment Co., 1020 W. 8th St., Plainfield, N. J.; Fitzgerald & Hudson, 150 Nassau St., New York City; Fred Lemcke, Park & Liberty Ave., Jackson, Mich.; Wylie Bros., Inc., Tulsa, Okla; R. L. McDonald, Inc., Springfield, Mo.; Anderson Tractor & Equipment Co., No. 1 W. Chapel Road, Biltmore, N. C.; Tennessee Tractor Co., 208 Fourth Ave., S., Nashville, Tenn.; Mine & Smelter Equipment Co., 306-12 S. Seventh Ave., Phoenix, Ariz; Lund & Co., 425-8 Dooley Block, Salt Lake City, Utah.

R. T. McClelland, Inc., Oakland, California, who have been Novo distributors for several years are now located in San Francisco and the firm name is Krantz-McClelland, Inc. The San Francisco address is 522 Bryant Street.

American and Concrete "Form-Hold" Merge

A report from the West brings the information that owing to growth of business the Concrete "Form-Hold" Corporation of Culver City has merged with the American "Form-Hold" Corporation, and extensive plans are being made for additional manufacturing facilities.

It is reported that the officers will remain the same, but the sales organization as well as manufacturing facilities will be increased. The American "Form-Hold" Corporation will actively administer the business of the Corporation.

Cutler-Hammer, Inc., Opens Warehouse at Cleveland

Cutler-Hammer, Inc., Milwaukee, Wis., announce the establishment of a warehouse at Cleveland, O. The company has leased 1,600 sq. ft. of floor space for the storage of stock for quick deliveries. A complete line of standard motor control equipment and wiring devices will be available for immediate shipment.

The territory to be served by these new facilities include Cutler-Hammer's entire central district consisting of the states of Ohio and West Virginia, the province of Ontario, western New York and Pennsylvania and sections of Maryland, Indiana, Tennessee and Kentucky. Sales offices for the district are located in Cleveland, Cincinnati, Buffalo and Pittsburgh.

Albany Firm Arranges to Handle Trackson McCormick-Deerings

Among the well-known distributors of general contracting machinery who have recently added tractors and tractor equipment to their lines is the E. B. Kelley Co., Inc., at Albany, N. Y., who is now handling McCormick-Deering Industrial Tractors, Trackson Tractor Equipment, and other related lines.

In addition to their establishment at Albany, these distributors have several branches in New York State and Pennsylvania. For many years they have handled concrete machinery of all kinds, derricks, hoists, pumps, and concrete plant equipment. Mr. E. B. Kelley, President of the Company, and other members of the organization are well-known to the contracting trade.

With their long experience in these fields the E. B. Kelley Company were quick to recognize the increasing importance of tractors, and especially crawler tractors, for contracting and industrial purposes. Consequently they arranged for the distribution of Trackson McCormick-Deerings, which they felt would best meet the demands of their trade.

Located as they are in the Capital of New York, these distributors are in the strategic position to get a big share of the State highway business, and they expect to do a big volume on their new lines this year.

Young Lady at Wheel of Trackson McCormick-Deering in Front of Albany Headquarters of E. B. Kelley Co., Inc.

waterworks—sewage disposal—filtration plant—power plant—chemical plant—piping and equipment

The "Q-check" symbol has been adopted as the trade-mark of the Cast Iron Pipe Research Association. Cast Iron Pipe thus marked is produced in accordance with established technical standard specifications by the leading pipe founders of the United States. Clow Cast Iron Pipe is all "Q-Check" pipe.

Insist on the "Q-Check" mark when specifying Cast Iron Pipe for gas, water, sewer, or industrial service.

Because, at Clow, ten thousand tons of pipe and piping equipment are ready now—and always—emergency, and everyday, piping jobs can be filled to better satisfaction.

What's more, Clow makes and stocks equipment carried by no other concern.

Also, Clow Engineers "take off" blue prints, accurately, completely. They estimate the exact cost of the entire piping job.

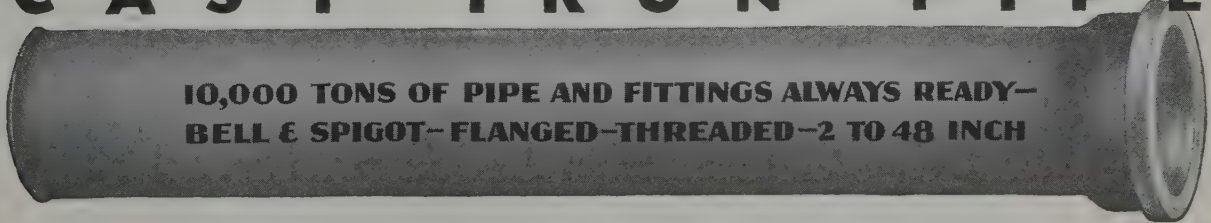
This huge Clow stock—more complete than any other—and this Clow service, can mean more profits for you, and faster, better piping jobs—gas or water.

JAMES B. CLOW & SONS, 201-299 N. Talman Avenue, CHICAGO

Foundries at: Coshocton, Ohio : Newcomerstown, Ohio : Birmingham, Alabama

CLOW-NATIONAL

CAST IRON PIPE



E. P. Goodrich and W. B. Powell Form Association as Consulting Engineers

Formal announcement has been received to the effect that Mr. Ernest P. Goodrich and Mr. William B. Powell will be associated as consultants to municipalities on all traffic matters both in person and through assistants where required.

Mr. Goodrich, who has recently been retained as engineering adviser to the Chinese Nationalist Government, has arranged with his associates so that during his absences from the United States his clients will continue to receive the services of men of the highest reputation and experience. Mr. Goodrich has specialized on traffic matters for many years, having been a member of each Hoover Conference, of the American Engineering Council and the American Engineering Standards Committees, chairman of the New York City Aldermanic Traffic Committee and many others. He is an honorary vice-president of the National Highway Traffic Association, and chairman of the special Traffic Engineers' Committee of the National Safety Council. His traffic surveys cover nearly fifty municipalities.

Mr. Powell is consulting traffic engineer of Buffalo, N. Y., chairman of the American Engineering Council and of the American Engineering Standards Committee on Signs, Signals and Markings. He and Mr. Goodrich will undertake street traffic and related studies for cities and other governmental units, will make recommendations as to traffic signal installations, and will supervise their purchase and installation. Their New York offices are at 175 Fifth Avenue.

Eldon S. Clark Heads Consulting Service Department

The Michigan Valve and Foundry Company has recently inaugurated a new service, whereby technical advice is made available to those in charge of projects involving water supply and distribution, drainage and sewage works, particularly where piping is an important factor.

The administration of this service has been turned over to Mr. Eldon S. Clark, a well known engineer who has been associated with many important projects throughout the East.

Mr. Clark's experience since graduating from the Massachusetts Institute of Technology has included the construction of hydraulic and railroad projects for Barrows & Breed; designer and assistant engineer on power plant work and industrial building construction for Stone & Webster, and assistant engineer with Metcalf & Eddy where he was engaged in water supply and sewage disposal work, in the designing and construction of systems.

Among some of the projects with which Mr. Clark has been connected are the distribution system at Waterville, Me.; water supply work at Plattsburgh, N. Y., including a large earth dam and connecting works; extensive housing development at Hopedale, Mass., which included water supply, drainage and sewage disposal works; design and supervision of construction for additions to distribution

Eldon S. Clark

systems at both Quincy, Mass. and Revere, Mass.; in a consulting capacity on the construction work of the large earth dam now being built at Johnstown, Pa., and the investigation of the adequacy of the water supply and the requirements for distribution to districts not formerly supplied at Concord, N. H.

Mr. Clark is affiliated with both the American Society of Civil Engineers and the Boston Society of Civil Engineers. It is his intention to co-operate closely with both municipal and industrial engineers in supplying needed information in both design and construction of work under their jurisdiction. Requests for this service may be made directly to Mr. Clark in care of the Michigan Valve & Foundry Co., 3631 Parkinson Ave., Detroit.

Penn Machinery Moves to Larger Quarters

In order to care for their enormously increased business the H. O. Penn Machinery Company, 18 E. 41st St., New York City, are moving their general offices and warehouse to Bronx, according to statement of Mr. T. A. McDonald for the company.

The warehouse, now located at 134th St. and Third Ave., is being moved to Port Morris Terminal at 140th St. and East River, Bronx, New York, where extensive property has been leased. It is stated that by May 1 the warehouse and general offices will be fully established at the new location, thus placing this company in the front rank in the matter of office and warehouse facilities.

H. O. Penn Machinery Company is well known in the field of construction and industrial equipment distribution, handling Byers cranes and shovels, Chain Belt pavers and mixers, Rex pumps and saw-rigs, Butler bins and weighing devices, O. K. compressors and hoists, etc. In addition to the equipment named, they have recently secured the exclusive agency in their territory for the International Harvester tractors.

Stearns-Roger to Represent Chicago Pneumatic Tool in Intermountain Country

Announcement has been received to the effect that the Stearns-Roger Manufacturing Co. will act as agents for the Chicago Pneumatic Tool Company of New York, this to be in addition to its engineering, manufacturing and contracting business.

Messrs. Barrett, Townsend and Bartlett, who have been connected with the compressor and drill departments for so many years, will explain to all operators the merits of the various machines offered.

A complete stock of compressors, both stationary and portable, rock drills, pneumatic tools and repair parts will be carried in the Denver warehouse, 1720 California St., Denver, Colo.

Contractors Equipment Co. to Handle Manitowoc Products in Michigan

Announcement has just been made by Manitowoc Engineering Works, Manitowoc, Wis., that Contractors Equipment Company, Detroit, Mich., has taken on the sale and servicing of Moore speedcranes, shovels, draglines and trenchoes, also the Buffalo-Manitowoc clamshell bucket, in the state of Michigan.

W. T. Morgan Joins Chicago Pump

W. T. Morgan formerly with Gould's Pumps, Inc., has joined the Chicago Pump Company. He will be located at the New York Office, where he will serve as manager of Engineering Service. Architects, engineers or contractors in need of pump information will be referred to Mr. Morgan.

Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, will be located at 819 Wrigley Building, 400 N. Michigan Ave., Chicago, after May 1.

SERVICE PIPE of COPPER or BRASS

protects health and cuts down repairs

COPPER AND BRASS *cannot* rust. By using them for service pipe, you protect the city water department from complaints arising from poor flow or discolored water. You safeguard the health of citizens. And you minimize the possibility of expensive repairs with consequent digging and paving work.

By urging the use of Brass for all *interior* water piping in the homes of your city, you make sure that the pure water supplied by the city will reach consumers in its original, clean, healthful state.

Copper or Brass pipe may cost a little more than the rustable or so-called *rust resisting* kind. But the many years of trouble-free service that they give make them a very worth while economy in the long run. Because they *cannot* rust, they do not leak or clog.

This association will be glad to supply full information about Brass or Copper pipe or cooperate with you to the fullest extent in any efforts you care to make toward furthering the use of these rust-proof pipes in your municipality.

COPPER & BRASS
RESEARCH ASSOCIATION
25 Broadway, New York

Midwestern Office:
Landreth Building
St. Louis, Mo.

Canadian Office:
67 Yonge Street
Toronto, Ont.

Pacific Coast Office:
Architects Building
Los Angeles, Calif.

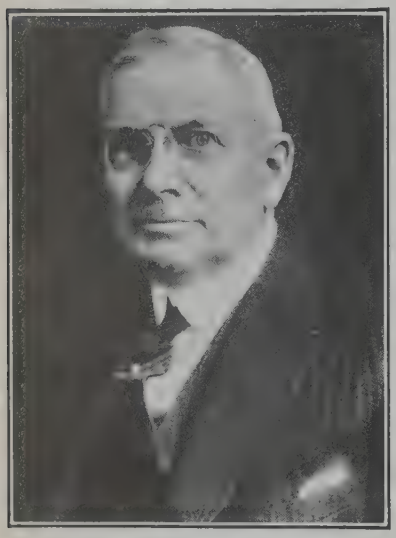
COPPER, BRASS, BRONZE — *The World's Most Useful Metals*

Theodore F. Merseles

The death of Theodore Frelinghuysen Merseles at Del Monte, Calif., on March 6th, removed from the business world one of its most successful organizers and managers, and one of the world's outstanding masters of practical merchandising, selling and administration.

Mr. Merseles was born August 17, 1863, in Jersey City, a descendant of Early Dutch settlers. He finished school at eighteen and began his long career of business achievement with the Pennsylvania Railroad and Trunk Line Association as clerk and stenographer.

His instinctive merchandising genius first found an outlet through the Western Wheel Works in the middle nineties when the bicycle fad was at its height.



Theodore F. Merseles

Competition in the field was intense, and as vice-president and general manager of this small company Mr. Merseles negotiated a combination with Col. A. A. Pope of Hartford and A. G. Spalding of Chicago, resulting in the American Bicycle Company, known as the "bicycle trust," with himself as vice-president.

In 1903, at the age of forty, Mr. Merseles decided to seek other fields of endeavor, and seeing opportunity in the mail order business, joined the National Cloak and Suit Company, which was then doing an annual business of about one million dollars. For eighteen years he stayed with this company, becoming vice-president and general manager. When he resigned in 1920, to become president of Montgomery Ward and Company, the business of the National Cloak and Suit Company totaled fifty million a year.

Selected by J. P. Morgan and Company to guide Montgomery Ward out of its post-war $9,000,000 deficit of 1920, Mr. Merseles with his new policies, new merchandising plans and able leadership brought this pioneer mail order house back to the top in its field until in 1926 its sales totaled over 185 million dollars and a profit of nearly nine million.

In 1927, J. P. Morgan and Company again called upon him, this time to become president of the Johns-Manville Corporation, which position he held at the time of his death. By application of his exceptional organization and merchandising ability he was again successful in increasing sales and profits, and in establishing and putting into effect further aggressive policies. The Board of Directors and Executive Officers of Johns-Manville have expressed the intention to continue and follow out all the progressive policies as planned and established by their president at the time of his death.

Mr. Merseles is survived by his widow, Mrs. Elizabeth Rich Merseles, and two sons, Herbert E. and Theodore I. Merseles. His home was in Bronxville, New York.

Chicago Pump Company Conduct School for Representatives

In order that the representatives of the Chicago Pump Company may give the architects, engineers, contractors and owners correct pump information where it is desired, the manufacturer has instituted a "Pump School," for instruction in the manufacture and merchandising of electrical centrifugal pumps. All new members of the Chicago Pump Company organization will be asked to go through the school.

The course is designed to educate the new men concerning the details of production, application of pumps and information necessary to properly figure a pump job. The production program calls for work in the machine shops, assembly floor, switch department, testing and service departments. The student also spends considerable time with experts to familiarize himself with the various conditions met with on pump jobs.

The three most recent graduates of the "Pump School" are Mr. Sidney Steiner of the New York office of the manufacturer; Mr. W. K. (Happy) Hornbuckle, representative at Memphis, Tenn., and Mr. Raymond Trethaway, who has taken the architect's engineering service, in order to cooperate with architects and engineers in Detroit, where he will assist "Tandy" Jackson.

"Business as Usual"

Mr. A. B. Chance, president of the Chance Company, Centralia, Missouri, believes in, "business as usual," despite such accidental interruption as fires.

When an explosion wrecked and set fire to the Chance Company warehouse recently Mr. Chance immediately telephoned the St. Louis Branch Office of the Truscon Steel Company for an engineer to assist in planning the replacement of the building.

Within four hours the engineer had traveled the 125 miles to Centralia and was estimating materials from hastily sketched plans. All night, while the fire burned itself out, the rebuilding program was revised and developed, and at 4:30 A. M. the contract for a new warehouse was signed while the ruins of the old one still smoked.

Work is being pushed to give the Chance Company a new Warehouse in record time. They make automobile and electrical specialties.

Cleveland Tractor Reports $100,000 in Cash Business from Two Orders

Mr. C. D. Fleming, vice-president of the Cleveland Tractor Company, reports the receipt of two large orders recently to add to this year's splendid record of sales. The orders were received from the State Highway Department of Arkansas and the Provincial Government of British Columbia, Canada, for large fleets of Cletracs.

These two orders alone, Mr. Fleming states, amount to more than $100,000 in cash business. Both orders represent repeat business for the company and bring the total number of Cletracs used by the Provincial Government of British Columbia up to eighty-two machines. The tractors are wanted for road construction and maintenance work.

The company reports notable progress in sales of large fleets of tractors to state highway departments throughout the country, individual purchases in some instances amounting to more than a hundred tractors.

Ferris Company to Handle United Tractor in Texas

The Ferris Tractor Company has been formed in Dallas, Texas, to distribute the full line of United Tractor & Equipment Corporation tractors and equipment in north and west Texas.

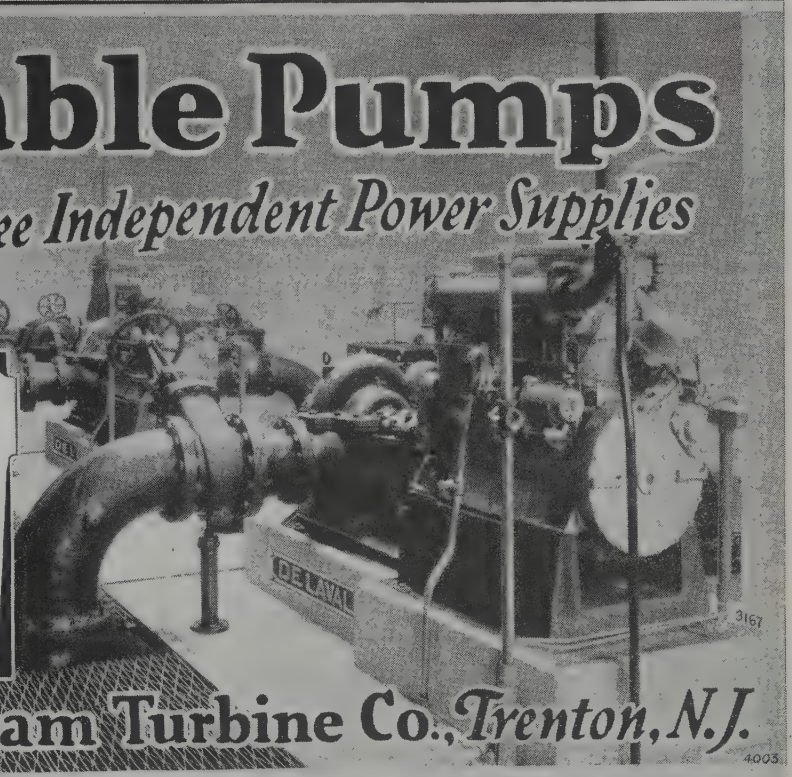
J. W. Ferris, president of the new company, has been connected with the tractor equipment business as president of the F-D Equipment Company, Fordson implement and equipment distributors, since its organization four years ago. F. A. Ferris, well known to the trade, will serve as vice-president, and H. L. Burleson as manager. Mr. Burleson has had 10 years' experience in the tractor and implement business in Texas, the past four with the F-D Equipment Company.

Change of Address

The New York Offices of Page Steel & Wire Company were recently moved from Grand Central Terminal Building to new quarters in the New York Central Building at 230 Park Avenue.

Reliable Pumps

with Three Independent Power Supplies



THE Bath Street Pumping Station of the city of Providence, R. I., is equipped with four De Laval centrifugal pumps, each having a capacity of 2000 gal. per min. against 98 ft. head. Two are driven by electric motors at 1750 r.p.m. and the other two by Sterling engines at 1200 r.p.m. De Laval centrifugal pumps are built to limit gages throughout, on an interchangeable basis. Parts subject to wear can be replaced by ordinary attendants, as the renewal parts do not require to be fitted. They are fully guaranteed as to head, capacity and efficiency, and are thoroughly tested before leaving our Works. If you are interested in pumping water or other liquids, ask for Catalog B.

De Laval Steam Turbine Co., Trenton, N.J.

4003

ELEVATED TANKS

STANDPIPES AND STEEL RESERVOIRS

— FOR —

WATER WORKS

Bardstown, Ky.—150,000 gallons

Wherever water is needed, Pittsburgh-Des Moines elevated tanks, standpipes and steel reservoirs furnish economical, dependable storage. Large cities are giving better water service by installing several tanks for auxiliary storage in their outlying districts. Small communities are improving their systems and insuring steady pressure by installing a single central tank.

Our nearest office will gladly submit designs and estimates of storage tanks for your requirements.

Write for Booklet No. 2

Pittsburgh-Des Moines Steel Company

4 Neville Island, Pittsburgh, Pa.
906 Tuttle Street, Des Moines, Ia.

New York · Chicago · San Francisco · Atlanta · Seattle · Dallas

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Executive with 20 years' experience in selling contractors' and builders' machinery and equipment, is starting new organization and would like to hear from manufacturers desiring representation in Northern California.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Representatives Wanted

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the Southwest and Middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Our June Issue

The June issue of Municipal News and Water Works, which is to be a combination of the Water Works Convention issue and the 1929 edition of Water Works Catalog and Data Book, will contain a Geographical Index of Dealers and Distributors who handle the products of advertisers in the Catalog section.

The material for this Index was furnished by the advertisers, so if there are any distributors, representing advertisers, whose names are not listed call the attention of the manufacturers whom you represent to this in order that correction can be made when the list is revised.

The Water Works Catalog will take its place as a service book on the waterworks field as a worthy companion of the Road and Street Catalog and Data Book serving the highway field.

Change of Address

Announcement is made of the removal of the general offices of the United Iron Works, Inc., from Kansas City, to the 14th Floor of the Hunt Building, Tulsa, Oklahoma. It is stated that this location will better enable the company to care for their business in the oil industry field.

Automatic closing provides absolute safety if a break occurs

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

automatically maintain a uniform water level in feed - water heaters, tanks, reservoirs and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

GOLDEN-ANDERSON
Automatic "Cushioned" Controlling Altitude Valves

These valves are always cushioned in closing and opening. They are extensively used for automatically maintaining a uniform stage of water in reservoirs, tanks and standpipes. No floats or fixtures inside or outside of tanks. No freezing troubles.

Three ways of closing these valves:
1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

Sizes to 24 in.

"Works Both Ways"

Remember

Valves Cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

GOLDEN-ANDERSON
Patent Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 in. to 24-in.

Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.

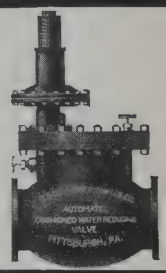
Sizes ½ in. to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipes, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—Most satisfactory float valves known.
4. No metal-to-metal seats—No water hammer or shock.
5. Cushioned by water and air.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operate quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.



CAREY Elastite can be ordered in any quantity, from an armful to a trainload. And usually the shipment is on the way within forty-eight hours. Store it anywhere, pile it high—it does not weaken or warp with time.

The Philip Carey Company
Lockland, Cincinnati, Ohio

Carey Elastite
EXPANSION JOINT

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Meter Boxes, Valve Housings, Etc.—A new ten page folder has just been received from H. W. Clark Company, Mattoon, Ill., illustrating and describing their gray iron products. The meter boxes are equipped with Wonder Lock, the key serving as handle of box, which cannot be removed without locking box. Products shown are: Meter boxes, box covers, wonder lock, valve boxes, valve housings, extension rings, repair lids, service box wrenches, etc. Illustrations clearly bring out the advantages of these products.

Airports.—"Getting on the Air Map with Caterpillar" is the title of a very attractive booklet issued by the Caterpillar Tractor Company, San Leandro, Cal. Booklet states: "There are more than 1,000 airports in the U. S.—some still in the making. The country needs 10,000." Booklet gives much interesting information concerning what is being done in various parts of the country to meet this need. Send for a copy, kindly mentioning our magazine.

Foundries.—Three folders, of special interest to foundry men, have just been issued by the Link-Belt Company, 910 S. Michigan Avenue, Chicago. These booklets describe the Continuous Malleable Foundry of the Saginaw Malleable Iron Division of General Motors Corporation; the three foundries of the American Manganese Steel Company, and the Link-Belt Vibrating Screen. The Link-Belt Company will be pleased to send copies upon request. If writing kindly mention our magazine.

Sluice Gates.—W. C. A. No. 32 issued by Rodney Hunt Machine Company, 101 Lake Street, Orange, Mass., gives some valuable information on sluice gates and hoisting equipment. This company, manufacturers of water controlling apparatus, will be pleased to give you detailed information about their hand operated, motor operated and hydraulic cylinder operated hoists and stands and accessories for all types of sluice gates, wide bronze facings, eliminating corrosion.

Concrete Pipe.—A very attractive book, giving much useful information on the sanitary engineering field as it applies to concrete pipe, is that issued by the Independent Concrete Pipe Company of Indianapolis, Ind. It is printed on heavy enamel paper, with many clear and comprehensive illustrations and is stitched into a heavy cardboard cover of pleasing appearance, putting the information into permanent form. In addition to a short history of the field, it gives the design, specifications and manufacturing methods of Independent Reinforced Concrete Pipe. The illustrations show manufacture and installations in places described.

Reinforced Concrete Pipe.—A pamphlet issued by the Lock Joint Pipe Company of Ampere, N. J., gives complete description and illustrations of reinforced concrete pressure pipe, which is of three kinds, poured pipe, cylinder pipe and centrifugal pipe and with expansion joints of two types, "Lead and Iron Joint" and "Lead and Steel Joint." All forms are steel held by cast-iron rings, insuring great accuracy and especial smoothness. In addition to photographic illustrations booklet contains several blue print drawings. Copies may be secured from eastern office, or from Chicago branch at 110 S. Dearborn Street.

Wrought Iron.—The A. M. Byers Company, Pittsburgh, Pa., has issued in handsome pamphlet form a reprint from World's Work "The New Story of Ancient Wrought Iron," by Donald Wilhelm. This is a story of the making of wrought iron from the earliest record down to the Aston Process put into practice last year by the A. M. Byers Company at their plant near Warren, O., and for which a new plant is being constructed at Ambridge, Pa. The manufacturer will no doubt be pleased to send copy of this reprint to anyone interested.

Street Department Supplies.—Catalog No. 31 issued by the Safety Gas Main Stopper Company, 523 Atlantic Avenue, Brooklyn, N. Y., bound in loose leaf type, illustrates and describes a long list of products including gas main bags, main plugs, stoppers, gauges, pipe cleaning brushes, cylindrical stoppers for water mains, etc. The new gauge and gas bag valve combination eliminates guess work in the use of inflatable bags and stoppers on which a pump is used. The pressure gauge shows when the pressure is sufficient and whether the bag is holding or losing air.

Mixer.—Koehring Company, Milwaukee, Wis., will be pleased to send you a special circular on the Koehring Weigh Mix, a standard heavy duty mixer with weighing batch hopper and water tank mounted on an auxiliary frame. All operations are controlled from platform, all aggregate is weighed in one hopper and water weighed on same beam.

Deep Well Power Plant.—The United Iron Works, Inc., Tulsa, Okla., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems.

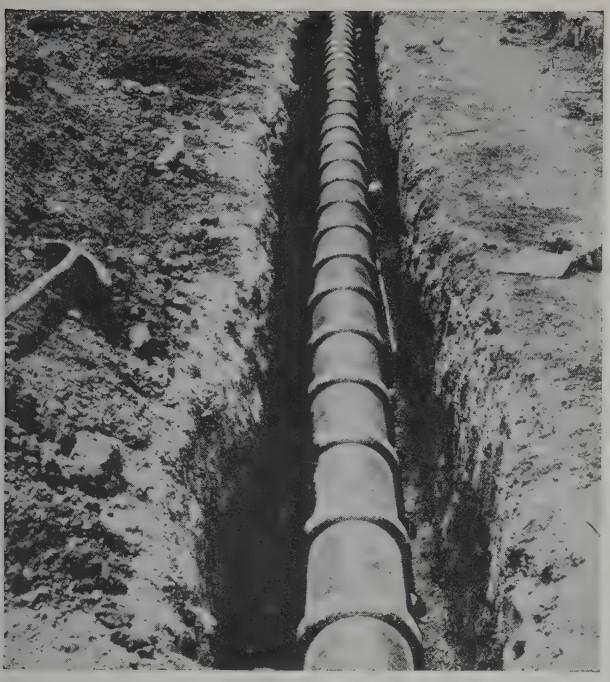
Water Meters.—For literature on water meter setting and testing equipment write to the Ford Meter Box Company, Wabash, Ind. Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently.

Sewer Cleaning Machine and Rods.—W. H. Stewart, P. O. Box 581, Jacksonville, Fla., and branches in St. Louis and Boston, as well as factory in Walkerville, Ontario, will be pleased to send literature describing his sewer cleaning machine and conduit rods. Folder describes the hand power machine or the Wonder Bucket equipment. Sewer rods are also illustrated and described, and a list of hand tools for use with sewer rods. This sewer cleaning device will remove anything possible to get into a sewer and clean thoroughly with the least possible difficulty.

Zeolite.—The Zeolite Chemical Company, 140 Cedar Street, New York City, will be pleased to send you "Softening Municipal Water Supplies by the Use of Zeolite," a booklet which describes green sand, a natural base exchange Zeolite mineral, used for water softening. Much interesting information is given.

Stillson Wrenches.—Sando Original and Moroco Popular Stillson wrenches, formerly made by the Moore Drop Forging Co. of Springfield, Mass., are now manufactured by the Trimont Manufacturing Company, 55 Amory Street, Roxbury, Boston, Mass. The Sando has a drop forged handle and jaw, and is scientifically hardened for maximum strength. Handle is made in wood or steel type. Both Sando and Moroco are described and sizes and prices given in booklet which will be sent by manufacturer upon request.

Fire Hydrants and Valves.—The Mathews Fire Hydrants built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia, Pa. A broken Mathews can be replaced is a very few minutes and without excavation or breaking up the pave-



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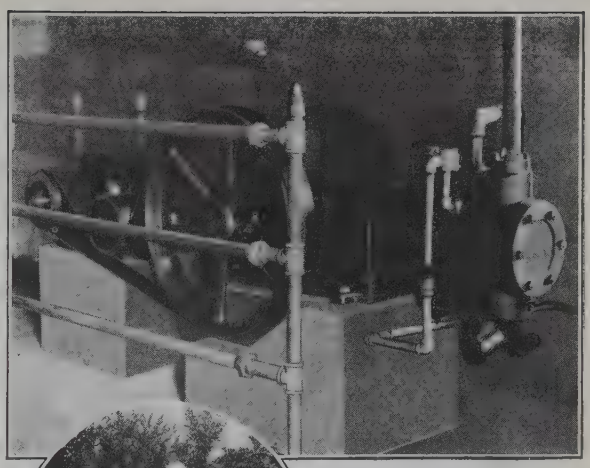
MN&WW—S—Gray



Water Works, Once a Burden —now pays dividends with Sullivan Air Lift

For forty years, Greenleaf, Kansas, had water troubles. Many pumping systems were tried; but ample water was never certain; and repair bills in the pumping plant looked like power bills.

Then modern Sullivan Air Lift and "Air Made" Wells were adopted. The water supply became generous and permanent. And the Water Works changed from a burden on the people, to a revenue earner.

Greenleaf takes water from sand and gravel beds, forty to sixty feet from the surface. Fine screens were used in this strata to keep out the sand. But the sand choked the screens, and slowed up the wells. Coarse screens were tried, and sand cut the pumps.

But today, with the Sullivan Air Lift System—sand is repeatedly removed from the well and replaced by coarse gravel. Collecting basins grow larger and larger; and more and more water flows into the wells. Maintenance on the Air Lift System for three years was barely $10.00. And seventy thousand gallons of water are sold daily to the Missouri Pacific Railway.

There are no moving parts in Sullivan Air Lift Wells, to wear or suffer damage—no working barrels or sucker rods to pull—no trouble from varying water levels or crooked wells.

For you too—Modern Sullivan Air Lift means more water and less trouble. You will be interested in the latest information contained in the Sullivan Booklets.

Send for Catalogs.

Sullivan Machinery Company
418 N. Michigan Ave., Chicago

SULLIVAN AIR LIFT

For dependable water supply anywhere

ment. Manufacturer will be pleased to send you full information.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., have had reprints made of a paper by Harry F. Ferguson (chief sanitary engineer, division of sanitary engineering, department of public health, Springfield, Ill.), and Clarence W. Klassen (assistant sanitary engineer, division of sanitary engineering, department of public health, Springfield), and appearing in the January issue of the Journal of the American Water Works Association. The title of the paper is "Are Your Wells and Reservoirs Contaminated?" The report treats of sources and reasons for water contamination, and states: "If owners of public water supplies overlook * * * or permit * * * contamination to continue * * * such owners * * * would be liable for damages for any illness * * * in accordance with recent court decisions." Wallace & Tiernan Co., Inc., will be pleased to send you a copy of this reprint, together with their technical bulletins describing their Chlorinators. Chlorination in the instances cited in the report would have protected the public health. Write for this literature.

Traffic Signals.—Catalog No. 129 has been issued by the Interflash Signal Corporation, 120 Broadway, New York City, describing Interflash "U. S. Standard" road signs and beacon signals for day and night service. Catalog describes the various types illustrated for use on highway and at street intersections where only a warning or cautionary signal is required. These are operated by either self-contained acetylene gas flushing equipment or direct from electric power lines. If interested in all-electric type of control signals ask for Catalog No. 229. For navigation lights for lighthouses, towers, buoys, wharves, bridges, etc., write for Catalog No. 329.

Chemicals.—The Kalbfleisch Corporation, 200 5th Avenue, New York, will be pleased to send you booklet on this subject in its connection with industries. The booklet is very handsome appearing, containing 84 pages, the first part being devoted to the sources, manufacture and uses of chemicals, together with a long list manufactured by the company—industrial and miscellaneous chemicals. The tables at the back of the book give atomic weights, corrections for temperatures and many other tables to serve the chemical user.

Hot Process Water Softener.—A new 12 page catalog in loose leaf style, Bulletin No. 5049, has just been issued by the Graver Corporation, East Chicago, Ind., describing their hot process water softener. Catalog gives views of installations and the component part of the softener. Booklet also contains tables showing savings made by use of softener. An extension to the front cover printed in colors enables the reader to refer to it as he reads the text of the booklet. An informative and attractive bulletin.

Paint Spray Brush.—Simons Paint Spray Brush Co. of Dayton, O., have issued a little booklet describing their paint spray brush and electric and gasoline air compressors to use with it. Containers, fittings, etc., are described and illustrations show the brush at work. For difficult painting jobs, such as large steel water towers, highway bridges, etc., this equipment saves in labor and paint. Ask for a copy of booklet G.

Tractors.—Catalog B-100 issued by Foote Bros. Gear & Machine Co., 215 N. Curtis Street, Chicago, covers all three models of the Bates "Steel Mule" tractor, 30-40-80. The Bates "Steel Mule" is easy to handle, has few wearing parts, and powered by Waukesha motor, it operates at high efficiency at all operating speeds. The crawlers run full length of tractor so it cannot nose into a bank with its radiator. Equipped throughout with IXL-ITE tool hard gears. Booklet fully illustrates, describes and gives specifications of all models.

Fire Hydrants, Gate Valves, Boxes, Indicator Posts, Etc.—A very attractive folder has been issued by the Iowa Valve Company, 701 Hubbell Building, Des Moines, Ia., giving the latest improvements on the products of this company, whose factory is located at Oskaloosa, Ia. Particular attention is called to the many improvements in the fire hydrant, such as the positive mechanical drip valve, bronze working parts, rubber mounted valve, new and improved adjusting feature which insures main valve in line with seat, all working parts removable through top of standpipe without use of special wrench or tripod, unrestricted water flow, delivering full pressure and simple construction. Folder gives description and illustration of fire hydrant and many of the other products of the company.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., manufacturers of chlorine control apparatus, will be pleased to send you full information concerning their MSP Chlorinator. This equipment in duplicate is protecting hundreds of small cities by safeguarding their water supply. Records of cities where this method is in use will be furnished as well as much interesting information concerning sterilization of water.

Centrifugal Pumps.—Booklet W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., contains much interesting information concerning their geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. Pumps for general water service, power plant service, sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. Write for literature.

Planning a Waterworks System.—This is the title of a little booklet which the Cast Iron Research Association, Peoples Gas Building, Chicago, will be pleased to send you upon request. No community of 500 persons can afford to continue without a waterworks system, and many smaller towns have excellent systems. Booklet discusses Engaging the Engineer; Plans; Source of Supply; Estimating Requirements; Pumping System; Duplicate Equipment; Storage Supply; Distribution; Pipe; Hydrants; Records; etc.

Sewage Treatment Plants.—Bulletin No. 101, dated February, 1929, has just been received from the Pacific Flush Tank Company, 4241 Ravenswood Avenue, Chicago, or 9 Park Place, New York, describing the Sprinkling Filter Design using the Twin Dosing Tank Equipment. It is a very comprehensive presentation of this type of sewage treatment, and contains many detailed illustrations and data concerning large plants in use throughout the country. There are several pages of design data for single and twin tanks with percentage tables. There are also cuts and descriptions of dosing tank counter, nozzles and Marley Tees.

Chlorinizer.—Bulletin No. 20 put out by the Paradon Manufacturing Co., Arlington, N. J., gives full description of Paradon Chlorinizer. Chlorinization is in universal use for sterilization of water supplies, sanitation of swimming pools and for the disinfection of sewage. Operation, advantages, capacity, types of chlorinizers, applicability and specifications are all given in bulletin, and a list of a few typical installations is also included, regarding the Paradon equipment, a chlorinating device for small water supplies, swimming pools, and sewage plants such as in use in small municipalities, factories, camps, estates, country clubs, hotels, etc.

Cast Iron Pipe.—Write to the Central Foundry Company, 420 Lexington Avenue, New York City, for information concerning the cast iron pipe with machined hub and spigot ends, all cast iron, eliminating calking or use of any jointing material. No tool needed but a wrench.

Manhole and Catchbasin Covers.—Wm. E. Dee & Company, 30 North La Salle Street, Chicago, will be pleased to send prices and full particulars concerning their D & D Safety Cover. They guarantee this cover not to rattle or dish.

Diesel Engines.—A bulletin from the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., has been issued describing the diesel power plant at Freeport, L. I., N. Y., where the 6th Busch-Sulzer Diesel—a 1,500 B. hp.—1,050 kw. unit, has just been purchased, making this the largest municipal Diesel plant in the United States, according to statement contained in folder. Their Diesel engines are built in 2-cycle and 4-cycle types, stationary and marine.

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TRIANGLE BRAND
Copper Sulphate
[99% Pure]

Unequalled in its effectiveness as
a Purifier and Protector
of water supplies
and for the
Clearance of Algae
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Affecting Reservoirs, Lakes and Pools and all bodies of standing water, due to the presence of aquatic micro-organisms.

Manner of application depends upon the particular species of organism treated.

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Write for our booklet on the "Use of Copper Sulphate in the Control of Microscopic Organisms" containing dosage table.

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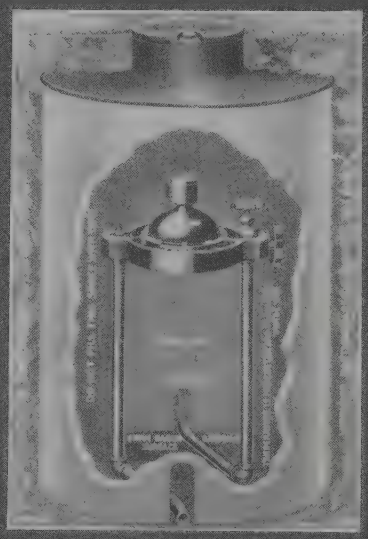
The ORIGINAL METER BOX

was built by Clark—36 years ago — and today the most scientifically designed and carefully manufactured Meter Box is built by Clark.



Clark Meter Boxes are built to meet every condition of climate, soil or traffic — no meter has ever frozen when properly installed in a Clark Meter Box. The "Perfect" and "Wonder" locking lids with which Clark Meter Boxes are equipped are strong, quick acting and tamper proof.

Send your specification for water distributing equipment to

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Meter Couplings
Service Boxes
Meter Testers
Valve Boxes and Housings
Trouble Finding Instruments

H. W. CLARK COMPANY
Manufacturers of Water Works Necessities
MATTOON, ILL., U. S. A.

Steel Storage Tanks.—Municipal Catalog No. 2 issued by the Pittsburgh-Des Moines Steel Company, 4 Neville Island, Pittsburgh, Pa., give description and information regarding the product of this company for taking care of water consumption during the peak hours and insures a constant pressure at all times. Use of these tanks eliminate fire hazards when repairs are being made at the pumping plant. Information will be furnished concerning complete water works system, pipe lines, reservoirs, filtration, purification, etc.

Fact Book of Steel Construction.—The American Institute of Steel Construction, Inc., 285 Madison Avenue, New York City, has just published a Fact Book which lists the steel fabricators of the United States, Canada, Mexico and Hawaii. It presents in chart and tables the statistics of steel, fabrication and construction work. In addition to presenting data relating to the tallest and largest buildings in the United States it also publishes for the first time the most complete list of steel bridges in the U. S. This book has been brought out because of the now general use of the skyscraper throughout the land and the widespread interest in the fabrication of structural steel.

Porous Concrete Well.—F. Thorpe, 1932 Illinois Avenue, East St. Louis, Ill., will be pleased to send you folder describing this type of well and will furnish a list of references. Some of the outstanding features are length of life, elimination of repair or maintenance costs, satisfied owners, etc.

Toledo Torch.—The new Toledo Torch "Champion" is the product of the Toledo Pressed Steel Co., Toledo, O. Write to the manufacturer for full information as to construction, service and costs.

Steel Sheet Piling.—Address Wemlinger, Inc., Singer Building, New York, or 228 North La Salle Street, Chicago, for information in regard to buying or renting steel sheet piling.

Clay Products.—Wm. E. Dee Clay Mfg. Co., 30 N. La Salle Street, Chicago, manufacturers of standard and double strength sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick, will be pleased to send you full information on any or all of these products.

Sewer Flusher.—Petersen's Hydraulic Flusher Company, 277 First Avenue, Milwaukee, Wis., will be pleased to send you literature illustrating and fully describing their sewer and pipe flushers. It is made in three styles of heavy grade canvas and waterproof tubing. A labor saving tool for city, contractors and manufacturers, and an economical way of clearing sewers.

Cast Iron Pipe.—An attractive folder from the McWane Cast Iron Pipe Company of Birmingham, Ala., and Provo, Utah, shows many successful uses for this pipe. It is used in parks for feeding sprinkling systems, by railroads in yards for water, air and low-pressure steam lines, etc., all of the 2-in. size. It is also made in 4, 6, 8, 10 and 12-in. sizes. Manufacturer will be pleased to send literature illustrating and describing pipe in all sizes for all uses.

Pumps.—Bulletin P-29 issued by the Jaeger Machine Company, Columbus, O., gives illustrations, specifications and full description of diaphragm, plunger type, lift and force centrifugals. The Speed Boy is a 4-cycle high speed engine with foot starter coupled with non-clogging big volume pump with Jaeger open type brass impeller that handles 25 per cent to 28 per cent solid matter such as sand, mud or solid stones. Write for this bulletin.

Cast Iron Pipe.—A very attractive booklet called "Small Diameter Cast Iron Pipe" has just been issued bearing the name of the American Cast Iron Pipe Co., Birmingham, Ala. Types of small diameter pipe described in booklet include: Simplex Prepared Joint Cast Iron Pipe; Two-Inch Bell-and-Spigot Cast Iron Pipe; Two-Inch Prepared Joint Cast Iron Pipe; Threaded-End Cast Iron Pipe; Doublex Simplex Cast Iron Pipe; Flanged Cast Iron Pipe; Cast Iron Pipe for Vitaulic Joints; Bronze Welded Joints and Small Diameter Cement Lined Pipe. Booklet is printed on heavy enamel paper and has an extra heavy cover.

Calatom.—An admixture for concrete which is mined, milled and refined exclusively by Monterey Products Company, Monterey, Cal., and distributed east of the Rocky Mountains by Tamms Silica Company. Calatom is a low water absorption diatomaceous earth for workability and waterproof concrete. Write to the Tamms Silica Company, Stock Exchange Building, Chicago, Ill., for literature giving complete information concerning this powered admixture.

Deep Well Water Systems, Etc.—Alamo Engine Company, Hillsdale, Mich., has issued a very attractive 60 page booklet in loose leaf style, describing the use of Alamo-Dorward Rotary Power Head, for operating deep well and other types of reciprocating plunger pumps. Booklet contains cross sectional drawings, explanation of capacity table captions with several pages of capacity tables.

Meter Boxes, Couplings, Testers, Service Boxes, Etc.—Catalog No. 24 issued by H. W. Clark Company, Mattoon, Ill., gives full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for accessibility for repair work or replacements. Full particulars furnished on all equipment.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Centrifugal Pumps.—The Byron Jackson Pump Co., Berkeley, Cal., will be pleased to send you literature giving full information concerning centrifugal pumps for any purpose. They have branch offices in San Francisco, Chicago and New York, as well as Portland, Salt Lake, Dallas and Phoenix. Their deep well turbines make available the water from deep stream sources. Write for particulars.

Cast Iron Pipe.—"Spi-Cor" is the title of a little booklet issued by the American Casting Company, Birmingham, telling the story of a new era in "culverting." It gives much interesting information in condensed form on spiral corrugated cast iron pipe. If writing for booklet, kindly give the name of our publication.

Paved Invert Culverts.—"Paving the Culvert to Combat Erosion" is the title of a comprehensive pamphlet issued by the Armco Culvert Mfrs. Association, Middletown, O. This product is designed for use where culverts carry highly sedimentary streams, on steep grades, in mountainous country, storm sewers, etc. The booklet illustrates in detail the paved invert and describes tests applied in developing it. The culvert must be made to withstand hydraulic traffic within and vehicular traffic from above. The booklet describes the Armco system. Kindly give the name of our publication if writing manufacturer for literature.

Excavator.—Write to the Bucyrus-Erie Company, South Milwaukee, Wis., or Erie, Pa., for bulletin on their D-2 Diesel Drag-Shovel. This shovel is built for the hardest work at a minimum cost. Easily convertible to clam-shell-crane, shovel or dragline. Manufacturer will be pleased to furnish you with performance records of this equipment.

Filtration Plants.—The Norwood Engineering Company, Florence, Mass., has much information on the installation of filtration plants which they would be pleased to send you if interested in municipal plants. Write for records of Norwood Municipal Filtration Plants. Kindly mention our magazine.

"The Cleaning of Water Mains."—This is the title of a booklet issued by the National Water Main Cleaning Company, 32 Church St., New York, describing the method so successfully used by them for the past twenty years. Write for a copy, giving the name of our magazine.

Well Systems.—Write to Layne & Bowler, Inc., Memphis, Tenn., or any of their representatives located in all the principal cities, for information about the Layne Water Well Systems. They will be pleased to give you the benefit of their long years of experience in this field.

When You Come To The River

You Must Know Highway BRIDGE Engineering to Carry On Profitably

To the aid of the highway engineer, county engineer and municipal engineer comes this new and straightforward treatise, "Economics of Highway Bridge Types." It fits the needs of the practicing engineer who, when his road must span a stream, meets a specialist's problem.

Such an engineer makes no pretense of being a bridge engineer. Oftentimes he does not at first grasp the scope of the problem. For it is not the problem of building a bridge, but one of *economic analysis and type selection.* Millions of dollars have been wasted through improper type adaptations, unwarranted first costs and needless maintenance expense. It is on this point that this author so squarely places his finger. Squarely and with immeasurable helpfulness. Necessarily the question of costs is exhaustively treated, and this feature of the book alone earns it a place in every civil engineer's library. Cost curves, quantitative and qualitative analyses and such factors as flood insurance, rental values, etc., bring this work a scope that assures its value. Send for a copy, read it, —then decide whether to keep it.

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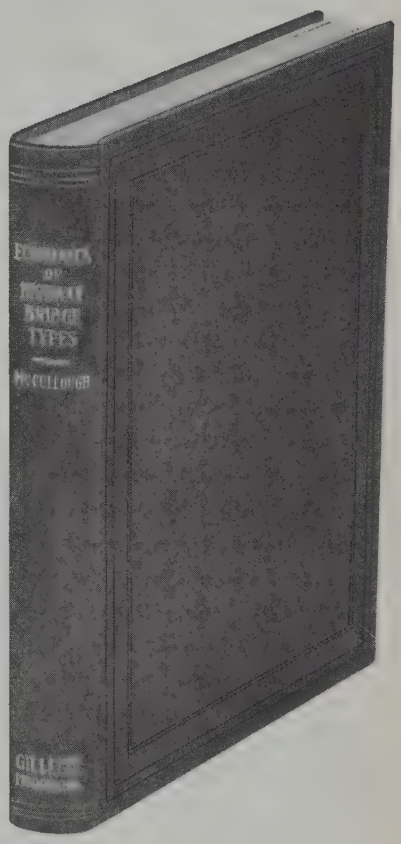

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by

C. B. McCullough, B. S., LL. B., C. E.

Bridge Engineer, Oregon State Highway Commission; Member Oregon Bar; Member A. S. C. E.; Special Lecturer, Oregon State Colleg

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WW-5-29

Centrifugal Pumps.—For a complete catalog on this equipment write to the DeLaval Steam Turbine Co., Trenton, N. J., asking for Catalog B. This is a very handsome 72-page catalog, discussing single stage and multistage pumps, for general water service, power plant service, including boiler feeding, condenser circulating and hot-well service, water works service, including main pumping units and booster, filtration and flushing service. Pumps for sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. The catalog is beautifully illustrated and gives cross sectional drawings showing details of pumps. There is a section on manufacturing methods and materials, and one on testing, also just what information should be furnished in seeking plant for individual requirements. Manufacturer will be pleased to send you a copy of this informative book. Kindly mention our magazine.

Forged Steel Gate Valves.—A very handsomely bound book is catalog No. 10, issued by the Darling Valve & Mfg. Co., Williamsport, Pa., containing 32 pages filled with illustrations and giving prices and specifications of this product. Each valve is given a rigid test before leaving the factory and is subjected to hydraulic pressure equal to its rated tested pressure. If valves of standard dimensions and design cannot be used, company will be pleased to be consulted concerning deviations. If writing manufacturer, give the name of our publication, please.

Cast Iron Pipe.—For complete information on McWane Cast Iron Pipe, "what it is," "what it does," fields it serves, types, specifications, quality, special features, etc., are all told in a 54-page booklet issued by the McWane Cast Iron Pipe Co., Birmingham, Ala. The territory west of the Rocky Mountains is served by the plant at Provo, Utah, called the Pacific States Cast Iron Pipe Co., of which Mr. J. P. McWane is president. Write to the manufacturer for a copy of this booklet on McWane precalked joint cast iron pipe and fittings. Kindly mention the name of our paper.

Dipper Trip.—A folder from the Morin Mfg. Co., 896 Main St., Holyoke, Mass., manufacturers of appliances and improvements, gives illustrations and detailed information about their Universal-Semi-Automatic Dipper Trip. This dipper trip may be adapted to any make or type of shovel, steam or air, gasoline, diesel, electric, or gas-electric and gas plus air. The outstanding features of this appliance set forth in circular are ease of operation and elimination of lost motion. Write for folder describing this equipment and also the friction-type dipper trip and tag line winder for gasoline, diesel and electric, and gas-electric and gas plus air shovels. If writing manufacturer kindly mention our magazine.

Rawhide Packing.—Mabbs Hydraulic Packing Company, 431 S. Dearborn St., Chicago, will be pleased to send you information concerning sizes, weights and uses of their rawhide packing. This packing is practically anti-frictional, will not cut or score metal surfaces and never becomes hard or glazed. It works equally well on centrifugal or reciprocating pumps. This packing has been found of service for the marine business, in cotton gins, for mining purposes and in oil fields on pumps and wells. It is put up in standard tin pails of from 5 to 50 lb. and in kegs and barrels of 100 and 200 lb. This company makes a specialty of rawhide washers for packing the stems of water meters. They can be ordered by meter companies in 100,000 lots. Write the manufacturer for further information, kindly mentioning our magazine.

For Water Works Campaigns.—Of interest to city officials and water works engineers in promoting campaigns for securing water works or renewals is the booklet issued by the Cast Iron Pipe Publicity Bureau of the Cast Iron Pipe Research Association, 122 S. Michigan Ave., Chicago. It is called Community Advertising, and shows colored reproductions of posters, street banners, direct mail literature and newspaper advertising to be used in securing this type of improvements for the home town. This campaign material will be furnished free by the association to aid in the cause of water works. Write for a copy of Community Advertising and find out just how much free help is available in aiding you with your problems. Kindly mention the name of our publication when writing.

Automatic Valves.—Catalog No. 24 has been issued by the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., to present with illustrations and descriptions their well known automatic cushioned valves for steam and water service and to call attention to many new styles of valves. The catalog contains 200 pages, well printed on enamel paper, with a complete index. A very useful and attractive catalog on valves. The Pittsburgh address of the Golden-Anderson Specialty Co. is Fulton Building. Kindly mention our magazine, if writing.

"Water Services that Serve" is the title of a brochure just issued by the Copper and Brass Research Association for distribution to municipal authorities, engineers and contractors. The booklet gives general data on copper and brass tubing and pipe with special reference to copper for use in service pipe between water mains and house lines. Tensile strength, bursting pressure tests, sizes, lengths and general data about installation are included in tables and explanatory paragraphs. If writing the assocation for a copy of this booklet, kindly mention our magazine.

Snow Removal, 1929.—This is the title of a very attractive booklet which the Caterpillar Tractor Co., San Leandro, Calif., has issued looking forward to the work and equipment which will be needed for next winter to keep the roads clear. Removal in Cities; Cost of Removal; America's Snowbelt and Loss to Business are some of the topics treated. Equipment for meeting these problems is illustrated and described. Send for a copy of this booklet and plan to meet this situation before it becomes a problem. Kindly mention our magazine, if writing manufacturer.

Fiber for Sweepers.—The Huntsville Fiber & Veneer Works, Huntsville, Ala., will be pleased to send you a copy of their attractive booklet "The Story of Huntsville Hickory." This booklet gives the complete history of the growing of hickory and manufacturing process of turning it into the "Faultless Hickory Fibers" for long-life street sweepers. It contains much interesting information concerning fiber equipment, as well as about the service this company is able to render. If writing manufacturer, kindly give the name of our magazine.

Leadite.—A self-caulking material for cast iron pipe manufactured by the Leadite Co., Land Title Bldg., Philadelphia, Pa. The manufacturer will be pleased to send you detailed information and records of pipe lines where this product was used. If writing, kindly give the name of our paper.

Sludge Removal.—The Link-Belt sludge collector is recommended by the manufacturer for its sturdy mechanism and reliability in removing sludge from sedimentation tank. An excess of accumulation of sludge will not slow down or stop operation. For complete information concerning this or other sewage treatment plant equipment, write to the Link-Belt Co., 300 W. Pershing Road, Chicago. Kindly mention our magazine.

Monarch Tractors.—Wise planning highway officials, who were snowed under during the past winter, will look to the snow removal machinery in time to have it on hand next year when the first snow flies. The Allis-Chalmers Mfg. Co., Milwaukee, Wis., will be pleased to send you literature concerning the outstanding features of the Monarch "75" with V-type plow for keeping the roads clear in the heaviest snows.

Compressors, Drill Sharpeners, Pneumatic Tools.—The Sullivan Machinery Company, 122 South Michigan Avenue, Chicago, Ill., will be pleased to send you a copy of their new eight-page folder, Form 2007, calling special attention to their portable air compressors, mounted to suit your requirements; drills, spaders, hoists and sharpener—all illustrated and described. Catalogs will also be sent upon request, write for information. Kindly mention our magazine, if writing manufacturer,

Engineering WEDS *Architecture*

The author of the new book herewith announced is Charles Evan Fowler, Consulting Civil Engineer, —Member of American Society of Civil Engineers, Engineering Institute of Canada, Society of Terminal Engineers.

Just Off the Press

"The Ideals *of* Engineering Architecture"

by C. E. FOWLER

Both architects and engineers will find tremendous stimulus in Mr. Fowler's new book, just off the press. The relationship between the two subjects is age-old, but here a new viewpoint is presented. Mr. Fowler's book is confidently expected to become the standard authority on artistic, or architectural design for Bridges, Buildings, Dams, Towers, Lighthouses, Sea Walls, Tunnel Portals, Retaining Walls, Piers, and all similar engineering structures. A closer bond will be formed between architecture and engineering, enhancing the beauty of the world.

You may have one of the first copies by sending your order at once. You will receive the book to read over and judge. Within 10 days you can remit $4 and keep the book or return it. Write today for your copy. Tear out this notice and use as an order by simply signing your name, address and occupation.

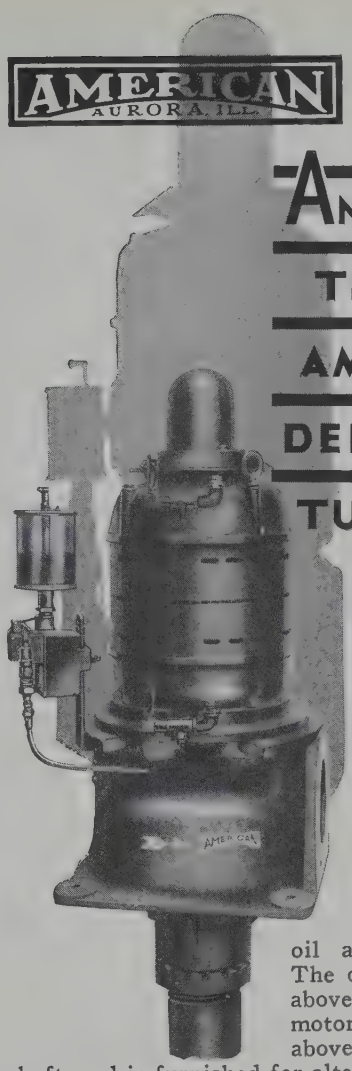
GILLETTE PUBLISHING COMPANY

Technical Publishers

221 E. 20th Street, Chicago, Ill.

AMERICAN
AURORA, ILL.

ANNOUNCING THE 6", 8" AMERICAN DEEP WELL TURBINES



The new 6 in. and 8 in. "American" Deep Well Turbines are ready.

Complete engineering data is now available.

The turbine head proper has great rigidity and compactness. Provision is made for complete drainage of all waste oil and water leakage. The discharge is located above the floor level. The motor is fixed directly above and to the pump shaft, and is furnished for alternating current.

The turbine proper is a special style of the turbine type of centrifugal and consists of one or more stages of suitable diameter to enter bored wells of 6 in and 8 in. inside diameter. The number of stages may be varied according to the head required.

The supporting pipe is made up in 10 ft. sections fastened together with steel screwed couplings.

All bearings are oil lubricated by gravity feed from the surface, the gravity feed being electrically controlled. The lower bearing of the turbine is of the peg type and a motor thrust bearing is provided to carry the load of line shaft.

Bulletins giving complete details of mechanical construction and performance under various conditions are now available, and will be furnished on request.

Branch Offices:

CHICAGO, ILL. 1615 First National Bank Bld. — NEW YORK CITY Room 523 - 165 Broadway — LOS ANGELES, CALIF. 416 E. Third St.

District Sales Agencies:

Boston, Mass.	Joplin, Mo.	Philadelphia, Pa.
Detroit, Mich.	Atlanta, Ga.	Kansas City, Mo.
Tulsa, Oklahoma	Dallas, Texas	Louisville, Kentucky
Denver, Colorado	Cleveland, Ohio	St. Paul, Minn.
St. Louis, Mo.	Charlotte, N. C.	San Francisco, Calif.
Omaha Nebr.	Pittsburgh, Pa.	El Paso, Texas
Birmingham, Ala.	Roswell, N. Mex.	Salt Lake City, Utah
Portland, Maine	Portales, N. Mex.	Vancouver, B. C., Canada

THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS *and Factory*

Sluice Gates.—Coldwell-Wilcox Company, South Water St., Newburg, N. Y., manufacturers of sluice gates, sheer, flap and butterfly valves, flexible joints, etc., will be pleased to send you full information concerning any of these products. If writing for catalog, kindly mention our paper.

Concrete Pipe.—Write to the Asphalto-Concrete Corporation, 1440 Broadway, New York City, for full information and manufacturing rights for the use of the Moir-Buchanan Centrifugal Process of making concrete pipe. Low manufacturing costs, low laying costs, high density, low absorption and long pipe life are features of this product.

Filter Sands and Gravel.—To meet the most rigid specifiactions on this product write to the Northern Gravel Company, Muscatine, Ia., for information on their "Standard."

Castings.—Write to the South Bend Foundry Company, South Bend, Ind., for information concerning their patented chilled manhole covers. Information furnished on all kinds of gray iron castings.

Francois Cementation Process.—The Dravo Contracting Co. have acquired the sole American rights to the Francois patents, and have a highly skilled staff who will be pleased to help you with your problems. This method of grouting covers chemical processes for a hundred and one different cases, the engineers of the Dravo Company are ready to help you solve your problems. Write to their company at Pittsburgh, Pa., mentioning our magazine.

Hydrants, Valves, etc.—Full particulars for supplies needed by water works and fire departments will be sent upon request by the Bourbon Copper & Brass Works Co., 618 E. Front St., Cincinnati, Ohio, manufacturers of fire hydrants, gate valves, and extension valve boxes. Write for their catalog, giving the name of our magazine.

Pumps.—New Catalog containing complete information on centrifugal pumps, plunger pumps, and deep well power heads may now be obtained by writing the American Well Works, Aurora, Illinois. Their engineering department will be pleased to discuss your needs with you, recommending the best equipment for your purposes. Kindly use the name of our publication if writing for information.

Disposal Plants.—Fairbanks-Morse and Co., Chicago, or any of their branch offices in the principal cities will be pleased to furnish complete details concerning their F-M Trash pumps for handling unscreened sewage direct from sewers. Write for information, giving the name of our publication.

Sanitary Specialties.—For information on a complete line of special sanitary products manufactured by the Servicised Products Corp., address the company at 6051 W. 65th St., Chicago. Among these products are bituminous rope, sewer compound, sewer belts, asphalt liner slabs, etc.

Road Oil.—Standard Road Oil is offered by the Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, for obtaining dustless dirt or gravel roads and giving a waterproof roadway. Write to the company for information on application.

Hydrants, Valves, Etc.—Write to the Columbian Iron Works, Chattanooga, Tenn., for descriptive literature of the Columbian Fire hydrants, Gate valves, Valve boxes, Hydrant extension sections, or other water works equipment. We would appreciate it if you would mention our publication if asking for information.

Cast Iron Pipe.—United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will be pleased to send you literature explaining the differences between the deLavaud Cast Iron Pipe and other types of pipe. This is a centrifugally cast pipe in which the graphite particles are finely divided and evenly spread.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, gives a detailed description and price list of parts in all sizes of their cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating. It will cut a piece one inch long or more at any point without starting joints or otherwise disturbing the main, and will make a clean cut in a gas or water main in the trench. Write to the Tucker Company for literature and price list of the Anderson Pipe Cutting Tool. In writing, kindly give the name of our magazine.

Water Meters.—Write to the Badger Meter Manufacturing Company, Milwaukee, Wis., for detailed bulletin on their complete line of meters, ranging in size from the smallest disc to the 12-in. turbine. This information will point out the way to reduce your pumping costs, by the use of the Badger Turbine Meter at the pumping station and the meters on the service lines. Many changes were made during the past year to increase efficiency and serviceability. If writing for literature, kindly mention our magazine.

Meter Repair.—For repairing or testing any make or size of water meter, write to the Reading Meter Repair Co., Inc., Reading, Pa., for prices and particulars. They will be pleased to furnish information concerning any hydraulic supplies and equipment.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Municipal News and Water Works, published monthly at Hammond, Indiana, for April 1, 1929.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Municipal News and Water Works and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Gillette Publishing Company, 221 E. 20th St., Chicago, Ill.

Editor—C. T. Murray, 221 E. 20th St., Chicago, Ill.

Managing Editor—H. P. Gillette, 221 E. 20th St., Chicago, Ill.

Business Manager—E. S. Gillette, 221 E. 20th St., Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Gillette Publishing Company, 221 E. 20th St., Chicago, Ill.

H. P. Gillette, 221 E. 20th St., Chicago, Ill.

E. S. Gillette, 221 E. 20th St., Chicago, Ill.

Mrs. R. W. Hume, 303 S. Stone Ave., LaGrange, Ill.

Winifred Gillette, 717 Bonita Drive, So. Pasadena, Calif.

Commonwealth Title Ins. & Trust Co., Chestnut and 12th St., Philadelphia, Pa.

Louise Forsythe, 13 E. Windermere Terrace, Lansdowne, Pa.

LaVerne Louer Hellyer, Ambassador Hotel, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

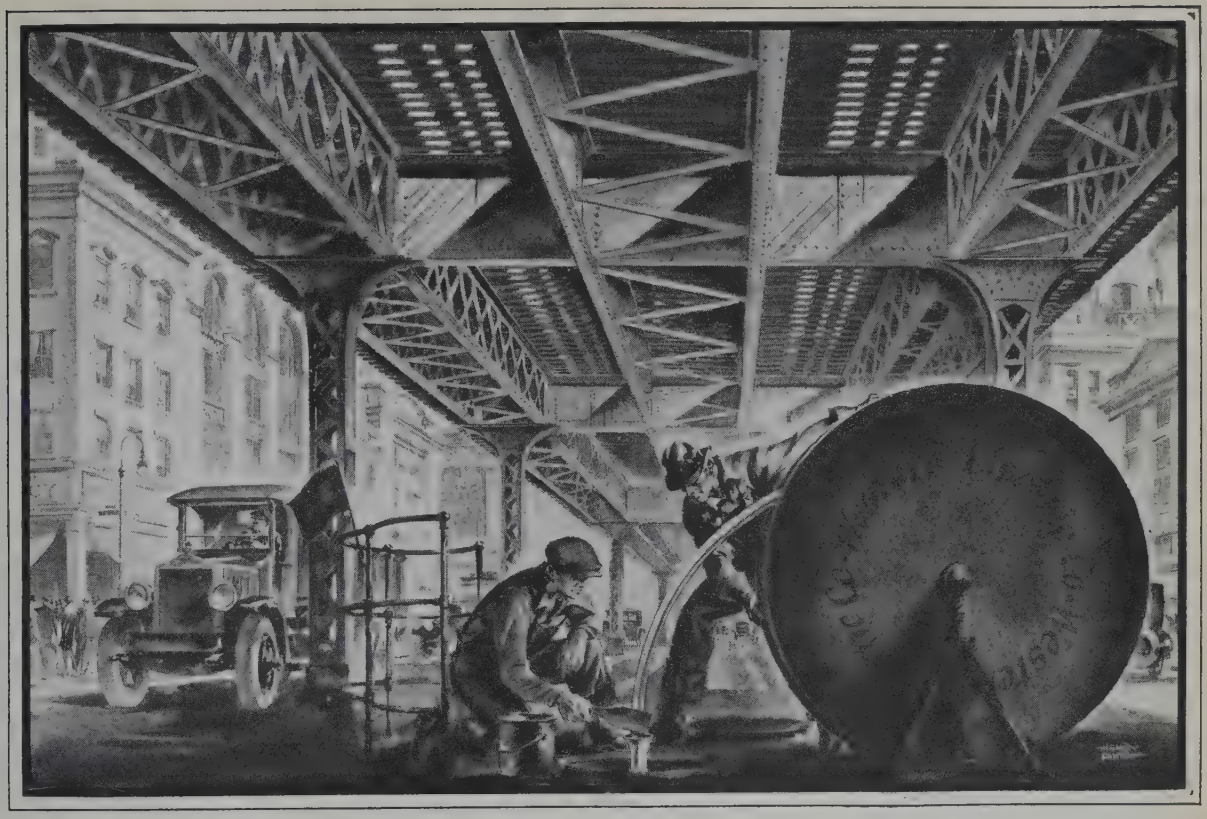
5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

E. S. GILLETTE.
(Signature of Business Manager.)

Sworn to and subscribed before me this 18th day of March, 1929.

KITTIE C. WOULFE,
(Seal) Notary Public.
(My commission expires February 9, 1930.)

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.



1800 conversations at once through a cable less than 3 inches thick

An Advertisement of the
American Telephone and Telegraph Company

The earth beneath our great cities is crowded. Steam, gas, sewer and water-mains, compressed air pipes, pneumatic tube systems, telephone and telegraph cables, light, power and rapid transit conduits lie so close together that any further additions create serious engineering problems. Yet the number of telephone calls that must flash through the underground arteries of great cities is steadily increasing.

The challenge to the scientific minds of the Bell System was to find a way for more conversations in existing conduits. Fifteen years ago, the pride of the System was a cable containing nine hundred pairs of wires. Then by many improvements a cable of twelve hundred pairs was perfected. It was rightly considered a scientific triumph.

Today, cables containing eighteen hundred pairs of wires are in service and these cables with every wire insulated are only two and five-eighths inches in diameter, one-half as large as the first nine hundred-pair cable. Eighteen hundred conversations at once—six hundred more than before—can now pulse through this two and five-eighths inches of cable.

There is no standing still in the Bell System. Better and better telephone service at the lowest cost is the goal. Present improvements constantly going into effect are but the foundation for the greater service of the future.

"The Telephone Books Are the Directory of the Nation"

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for Northern California territory. Now stocking equipment for several well known machinery manufacturers.

Man experienced in selling road building machinery to state highway departments, contractors, county and city officials, would like to make connection as district representative or branch manager. Located in Ohio, but would consider other territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Civil engineer located in Porto Rico would like to hear from manufacturers desiring sole representation for their products in Porto Rico, Santo Domingo and Venezuela. Machinery for highway construction, purification plants, steel for buildings or bridges or other building materials and contractors' equipment.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Representatives Wanted

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the Southwest and Middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

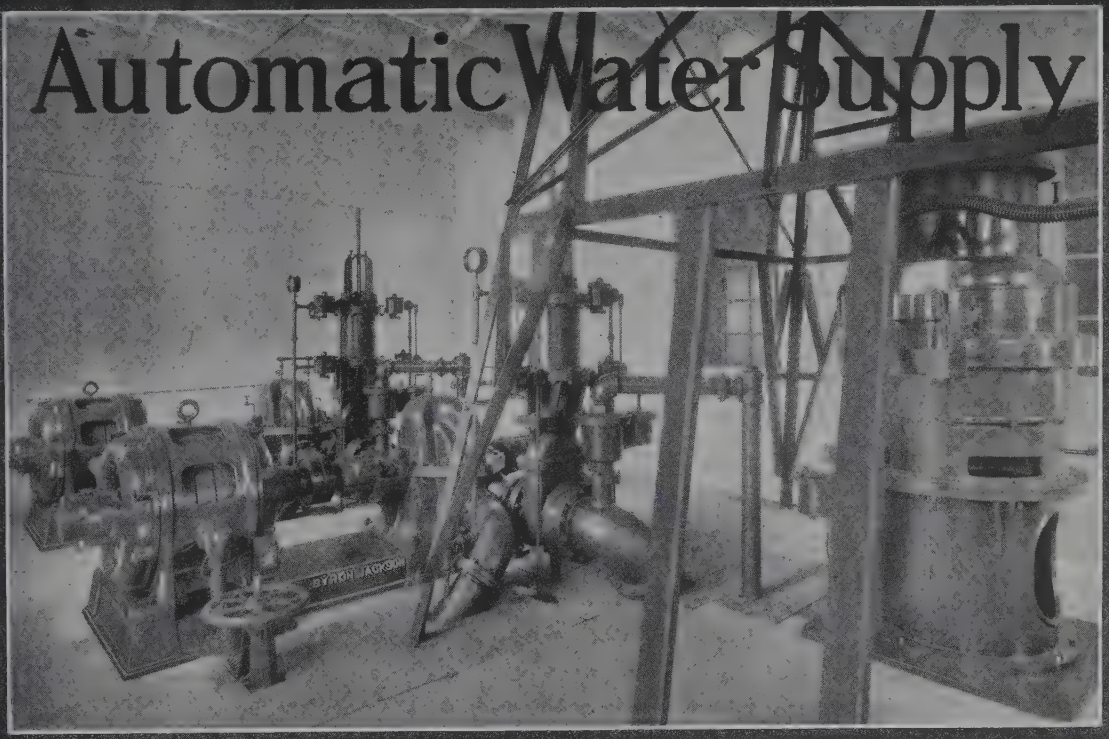
Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Nichols Copper Company who are building new tank house at El Paso, Texas, have let the contract for the electrolytic tanks and foundations to the Cement-Gun Construction Company of Chicago. This construction company have for years made a specialty of concrete electrolytic tanks.

Automatic Water Supply



Reliable Pumps for Water Works

BYRON JACKSON Service PUMP MFG CO.

Byron Jackson automatic water supply pumps are especially adapted for municipal purposes. In the above illustration is shown a Byron Jackson Deepwell Turbine pump that lifts water from underground sources, supplying the two Byron Jackson Multiplex high pressure booster pumps on the left. These pumps are noted for long life and trouble-free operation. Their completely automatic control is introducing a new era in water works practice.

SINCE 1872

BYRON JACKSON PUMP CO.

Factories: BERKELEY, Los Angeles, Visalia, Calif.
Branches: San Francisco, Portland, Salt Lake, Dallas, Phoenix
CHICAGO and NEW YORK

BYRON JACKSON

CENTRIFUGAL PUMPS FOR EVERY SERVICE

House Magazines

Editor's Note: This column is published every now and then. Many most attractive and interesting house magazines come to our desk from time to time, and we take this method of acknowledging them.

The Blue Band Bag.—This little leaflet is given the first place because it is so new and shining—Volume 1, No. 1. It isn't very big, but like so many small things very attractive. It is published by the North American Cement Corporation, 285 Madison Avenue, New York "for the purpose of acquainting you with its products and its policies." Thomas Dreier is the editor. The short items are easily read, but each one contains an idea worth thinking about. We quote one sentence: "Start right where you are with what you have."

The Mueller Record.—In contrast to Volume 1, No. 1 of the previously mentioned booklet, we present Volume XVIII, No. 201 of the Mueller Record, published by Mueller Company, Decatur, Illinois, of which C. N. Wagenseller is the editor. This is a 40 page magazine filled with items both grave and gay. The central article in the book is a description of the water works plant at El Centro, California. Another item of general interest is the illustrated description of Chicago's Gold Medal Building, known as 333 Michigan Avenue. It goes without saying the annual convention of the American Water Works Association was given due space.

The Labor Saver.—This 24 page booklet appears as issue No. 165 for the Stephens-Adamson Mfg. Co. of Aurora, Illinois. It is devoted to the "promotion of labor saving methods" and has as its editor Mr. C. H. Adamson. The lead off in this issue is devoted to the $5,000,000 addition to the Virginia Electric and Power Company plant at Norfolk, Virginia, enlarged to include 30,000 KW generator, 12,000-ton coal storage yard and the installation of Stephens-Adamson coal unloading and handling equipment. Booklet contains many illustrations and cross-sectional drawings explaining possibilities of the National material handling systems.

Bores & Strokes.—The Schramm, Inc., representative arrived with its usual punctuality in May, and contained a very interesting picture of a booth at a Fair in Czecho Slovakia, where the "Schramm" compressors seemed to be giving an excellent account of themselves.

Good Roads.—Published by the Good Roads Machinery Company at Kennett Square, Pennsylvania is now half way through its second year. This little paper is filled with distributor news concerning Good Roads equipment.

The Wood Hoister.—From Wood Hydraulic Hoist & Body Co., Detroit, Michigan, for May, contains some interesting information concerning profitable transportation of Wet-Mix.

The Dump Truck on the Job.—The organ published in the interest of the many users of dump trucks by the Hydraulic Hoist Manufacturing Company of St. Paul, devotes its center pages to a description of the New Eastern State Penitentiary at Graterford, Pa.; buildings more interesting from the viewpoint of those on the outside looking in, than of those on the inside looking out. This article is contributed by Mr. Leonard Rodenhausen of the firm Rodenhausen Sales & Service Company.

Caterpillar Magazine.—Another regular monthly visitor, representing the Caterpillar Tractor Company of San Leandro, California, brought with it its usual interesting "round the world views." There seem to be few places where men have been that Caterpillar has not been, and many places where men would not find the going so good but for the aid of the Caterpillar.

Shovel News.—The June issue of this twenty page booklet, published by Link-Belt Company, 300 W. Pershing Road, Chicago, contained several very interesting articles on recent construction work. Work on bridges and sea walls at Long Beach, California, sewer work in Kansas and levee construction along the Mississippi, makes interesting reading, and there are several others just as good in this one little booklet.

Monarch Track-Type.—Issue No. 3 of Volume 1 of this magazine of Allis-Chalmers Mfg. Company of Milwaukee, Wisconsin, pictures the Monarch at work on roads, logging, earth moving, working on the farm, and engaged in other peaceful and profitable occupations.

Meet J. A. Hanratty, Vice-President of Pioneer Gravel Equipment Co.

Friends of Mr. J. A. Hanratty have furnished the picture which is presented here, believing it to be the only one in existence, with the possible exception of one "way back when"—and even this one, to do him full justice, should show him to be about ten years older.

Just why Mr. Hanratty decided to become a gravel equipment sales engineer is something of a mystery, although rumor has it that gathering gravel for bird cages in his youth first lead to quantity production and later he just naturally took on the whole scheme of crushing, screening and loading plants. He says the bird cage business had nothing to do with the case, and that the Russell Grader Company did the pioneering in gravel machinery and that he joined them in 1919, specializing in the gravel equipment line and traveling all over the United States and Canada in the course of this work.

When the Russell Grader Company recently merged with Caterpillar Tractor, J. A. Hanratty, the Ellertsons, Brunsdale, York and the rest of the Russell Grader enthusiasts, together with W. H. F. Thompson, who report

J. A. Hanratty, Vice-President Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

says became interested in gravel through wearing low shoes, bought out this end of the Russell Grader business and incorporated under the name of Pioneer Gravel Equipment Manufacturing Company of Minneapolis.

Distributors and service stations have been established all over the United States and Canada and a new plant in Northeast Minneapolis, with 36,000 sq. ft. of floor space, has just been completed.

J. A. Hanratty's principal hobby is work, and with him work means gravel equipment machinery installation to fit every type of road building requirement. To accomplish this he is traveling so much over the face of the earth, advising with contractors and municipalities regarding their gravel equipment needs, that it is reported he calls his two little girls, aged 6 and 3½, "Pat" and "Jack," so much does he think of the problems of Pat and Jack at their road building work.

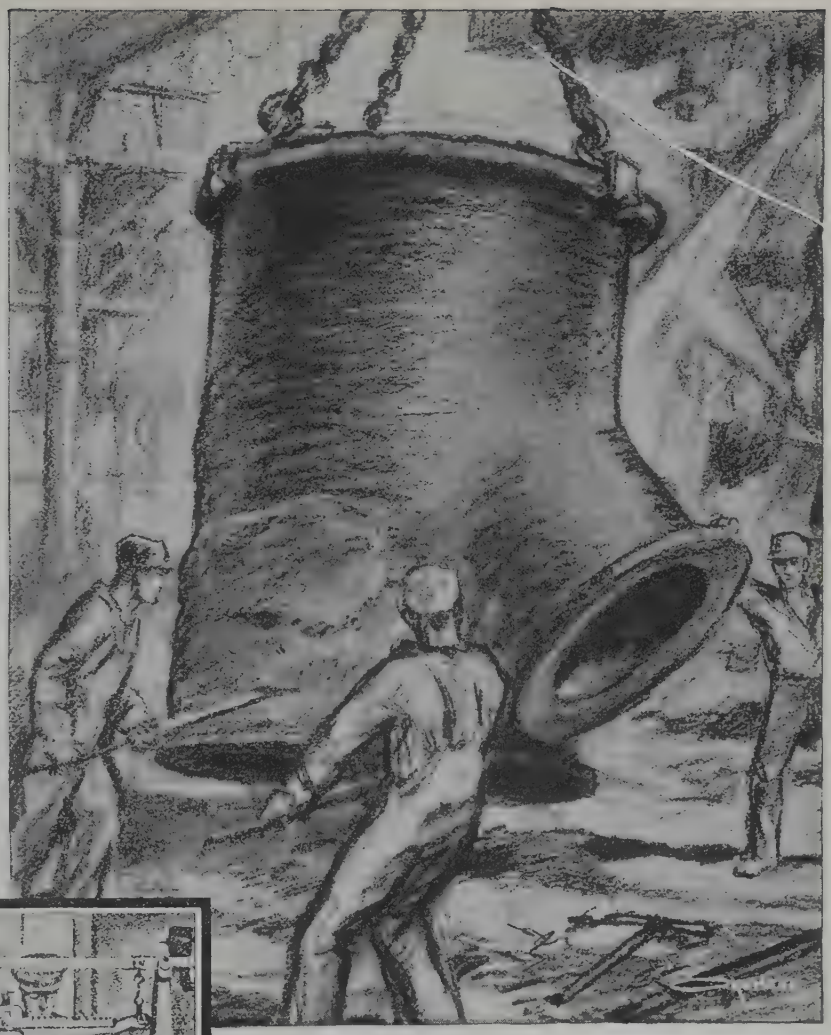
J. A. Hanratty is worth meeting.

Balzer Machinery Celebrates Birthday Party

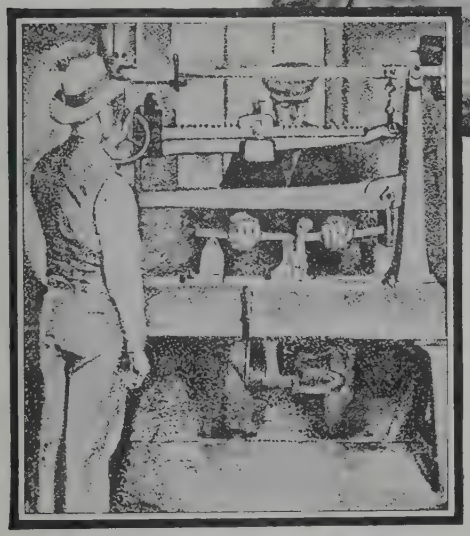
Although Mr. R. L. Balzer, manager of the Balzer Machinery Company has had over twenty years experience in the Portland territory in selling machinery, their organization has only recently celebrated its first birthday.

Before the organization of the Balzer Machinery Company, Mr. Balzer was long connected with the Clyde Equipment Company, and his experience at the head of that company, gave him many contacts with the trade.

Balzer Machinery Company is located at 267½ Oak Street, Portland, Oregon, and specializes on Gardner-Denver air equipment, General Excavator gasoline shovels, Wheeling roller bearing crushers, Owen clamshell buckets, and Ohio locomotive cranes.



In the modern foundry, cast iron specimen bars 26″ x 2″ x 1″ are tested from each run of metal. The bars when placed flatwise upon supports 24 inches apart must sustain a load of 2000 pounds at the center and show a deflection of not less than .30 inches before breaking.



CAST IRON

The "Q-check" symbol shown above has been adopted as the trademark of The Cast Iron Pipe Research Association. Insist on this "Q-check" mark when specifying cast iron pipe for gas, water, sewer, or industrial service. For complete information write to The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, Peoples Gas Building, Chicago.

SCIENCE and invention have been diligently employed in the ancient but alert industry of cast iron pipe manufacture. There are no wasted minutes or motions in the modern cast iron pipe foundry. The work proceeds with the smoothness of practised team-work. Old-time foundry men would doubtless be amazed to observe the many appliances used today to speed the production and assure the uniform quality of modern cast iron pipe.

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and proper use of Cast Iron Pipe. Pipe bearing the Association "Q-check" mark may be obtained from the following: American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Cast Iron Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

Copyright 1929, C. I. P. R. Ass'n.

CAST IRON PIPE

Wehr Company in New Home

Popular demand for the Wehr One-Man Power Grader, and the other Wehr products, has been so great that Wehr plant facilities required a recent expansion of large dimensions.

The new Wehr plant is located at Cudahy, Wis., a suburb of Milwaukee. The building is of modern brick, saw-tooth construction, and is exceptionally light and airy at all times. The outside dimensions are approximately 450 ft. x 360 ft., with about 125,000 sq. ft. devoted entirely to the manufacture of One-Man Power Graders, road rollers, and other Wehr products.

New Wehr Plant at Cudahy, Wis.

Side track facilities at the outside loading platform will accommodate eight to ten freight cars. Trackage inside the building will accommodate five freight cars for loading. Overhead crane facilities greatly assist in the speeding up and efficiency of production. Many thousands of dollars have been spent in the most modern equipment for the machine shop.

An efficient material-handling system has been established, whereby production per day has been increased over 400 per cent.

Office efficiency is increased through the establishment of personnel in a large area of "daylight" floor space.

Orders for Wehr equipment are being filled in rapid succession, and daily shipments are being made to every part of the country.

New and Up-to-Date Quarters for Penn Machinery Co.

Who isn't justly proud of new possessions? The H. O. Penn Machinery Company of New York City is no exception; and they extend a cordial invitation to the trade to visit them at their new headquarters at the Port Morris Terminal, 140th St. and East River, Bronx, New York.

The general offices as well as the warehouse are located at the new address, where ample facilities are available for the enormously increased business now being handled by the company. In making the change, the interests of the many customers have been kept in mind, with a view to giving the highest possible service. No expense has been spared to make the new facilities second to none, and with the large stock of equipment now carried, and the service arrangements, the officers believe they are in a position to meet any demand. A most complete service and parts stations will be maintained and 24 hour service will be rendered. The new location affords about 25,000 sq. ft. of warehouse space, all under cover, with railroad siding and literage delivery.

No change is announced in the personnel of the organization, and the officers are all well known to the trade. Mr. Hamilton O. Penn, from whom the firm takes its name, continues as president; Mr. Frank I. Ginsberg, vice-president, and Mr. E. Gwynn Robinson, secretary and treasurer.

In addition to the established lines that have been carried for several years, namely: Byers crane shovels; Rex pavers, mixers and pumps; Butler steel bins and weighing devices; Hotchkiss steel road and sidewalk forms; Archer mast hoists, and O. K. hoists and compressors, the company has now assumed the agency for the International Harvester tractors and accessories.

If in the neighborhood of the new headquarters, stop and see Penn Machinery Company, where you will receive a hearty welcome.

F. O. Weber to Represent Fusion Welding in Pennsylvania

The Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, manufacturers of welding equipment and supplies, announce the appointment of Mr. F. O. Weber, 229 Boulevard Des Allies, Pittsburgh, Pennsylvania, as sale manager for the Pittsburgh district.

Mr. Weber has been identified with the welding industry for a great many years.

"Inland Empire"

The recently organized Construction Equipment Company of Spokane, Washington, has announced the entire Inland Empire as their territory for the sale of contractor's equipment. For those of our readers who may not know just what territory is meant by this term which is well known in the Pacific Northwest, "Inland Empire" is used to designate the territory within a radius of about 200 miles from Spokane. It might be described as that part of the country bounded by the Canadian line on the north, the Oregon State line on the south, the Cascade Mountain Range on the west and the Montana-Idaho state line on the east.

Introducing Kratz & McClelland, Inc.

Mr. Carl E. Kratz, who has been identified with the construction equipment industry on the western coast for the past 20 years, has formed a partnership with R. T. McClelland, to be known as Kratz & McClelland, Inc.

The office and warehouse of this equipment company is located at 522 Bryant St., San Francisco, Calif. They are representing such well known manufacturers as the Ransome Concrete Machinery Company, Novo Engine Company and Chausse Oil Burner Company. Stocks of the various products of these manufacturers are carried at the warehouse, insuring prompt delivery and service.

Distributor News extends their best wishes to the new organization and is anticipating some good distributor stories from them.

Announcement

The Lincoln Electric Company, Cleveland, Ohio, manufacturers of "Stable-Arc" welders and "Linc-Weld" motors, announces the recent appointment of new district sales representatives. B. W. Brown has been advanced to district sales representative with headquarters at Milwaukee, Wis.

G. O. Forseth, formerly a sales representative at Detroit, Michigan, has been promoted to district sales representative with headquarters at Minneapolis, Minn.

A Change of Name

The Cornell Supply Company located at 7th and P Sts., Lincoln, Nebraska, have changed their firm name to the U. S. Supply Company. This organization represents the Chicago Pump Company.

The Chicago Pump Company announces several additions to their sales representation. Mr. W. H. Hornbuckle, manager of the Southern Sales Company at Memphis, will represent them in several states in the south. Mr. Ray Trethaway has joined the Detroit office, where he will handle engineering service. Mr. Sidney Steiner, after spending considerable time at the Chicago Pump factory, has entered the New York office, where he will have charge of pump detail.

P. S. Lord, 406 Weatherly Building, Portland, Oregon, has joined the sales staff of the Chicago Pump Company, with headquarters at address given.

The Wagner Electric Corporation of St. Louis, Missouri, announces the appointment of Mr. L. G. Tandberg as branch manager of its Los Angeles sales office.

RUST *destroys* Expensive Pavements

EVERY city, town and village boasts of its streets and sidewalks. Citizens point with pride to such improvements. When water service pipes which carry the water into the homes are made of corrodible metal they soon become rust clogged. The result is that when the home owner turns on a faucet only a tiny trickle of reddish water drips. The rusting service pipe soon bursts. Streets and lawns must then be torn up so that necessary repairs can be made. All of which results in a heavy financial burden to the taxpayer.

Copper or Brass water service pipe cannot rust. Municipal governments never have to tear up expensive pavements to make repairs and replacements.

Full information on the advantages of Copper or Brass pipe will be furnished you by this Association without cost or obligation on your part.

COPPER & BRASS
RESEARCH ASSOCIATION
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Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Street and Parking Signs.—A folder from the A. D. Joslin Manufacturing Co., Manistee, Mich., describes the Joslin line of weatherproof street signs. Standard street markers and parking and zone signs are illustrated. Joslin street signs are guaranteed to be readable for 10 years. The makers will be glad to provide you with a folder.

Motor Sweepers.—The Austin motor pick-up sweeper is described in Catalog No. 8, issued by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill. This is a sprinkler-sweeper with oscillating gutter broom and rear pick-up broom. The catalog contains specifications and detailed drawings, photographs and cross-sections of the sweeper. The manufacturers will be pleased to furnish you with a copy.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

Garages.—"Modern Garages" is a 24-page booklet issued by the Portland Cement Association, describing and illustrating multi-story reinforced concrete garages in cities all over the country. Interior and exterior views of the structures are shown. Most of the garages are of the ramp type. There is a brief statement of the essentials of garage design. Architects everywhere should be interested in securing copies of this booklet. Write to the Portland Cement Association.

Industrial Flooring.—The Wright Rubber Products Co., Racine, Wis., will be pleased to send you copies of their latest folders describing Wright rubber-block industrial flooring. Examples of Wright installations are shown, and a color index is provided.

Files.—Write to Heller Brothers Co., Newark, N. J., for a folder describing Vixen files. Flat, flexible and half-round files are illustrated. Each tooth of a Vixen file is individually milled and undercut, with the result that the action of the file is shearing rather than scraping. The manufacturers will be glad to discuss your filing problems with you.

Finishing Materials—Information on materials of all kinds for structural repairs and plant maintenance will be supplied by the Stone & Tar Products Co., 97 South Sixth St., Brooklyn, N. Y. Among the products described are waterproofing cement, concrete hardener, transparent spar oil, cement paint, steel coating, shingle stain and ornate-stone textural coating.

Air Compressors and Tools.—Write to the Ingersoll-Rand Co., 11 Broadway, New York, N. Y., for the latest bulletin describing Ingersoll-Rand portable air compressors and tools. Machines are available for rock drilling and pavement breaking, trench digging and backfilling, hoisting and hauling, grinding and surfacing, riveting, sheet pile driving, spray painting, tie tamping, etc. A table is included, giving the number of Ingersoll-Rand tools that each size of Ingersoll-Rand portable compressor will operate in general service.

Omicron.—A profusely illustrated and charted discussion of the deterioration of concrete floors through traffic and chemical disintegration has been published by the Master Builders Co., Cleveland, Ohio. It is a 28-page book entitled "The Fifth Ingredient." It is the claim of the authors that chemical agents, present everywhere, hasten the deterioration of concrete under traffic even where chemicals are not apparently present, but that this deterioration can be checked. The rapid deterioration of concrete floors in dairies, sugar refineries, paper mills, etc., according to the facts and illustrations in this book, is only an exaggerated example of the disintegrating action to which all concrete is subject. The effect of mechanical wear is also discussed. Free copies of "The Fifth Ingredient" may be secured from the Master Builders Co., manufacturers of concrete hardeners, waterproofings and allied technical products, 7016 Euclid Ave., Cleveland, Ohio.

Drill Steel Sharpener.—The Sullivan Machinery Co. has just published a new bulletin on its light model drill steel sharpener, class "C." This bulletin, No. 72-N, contains 16 pages and is fully illustrated with details of the sharpener and pictures of the machine at work. This sharpener is suitable for work on hammer drill bits and shanks for the lighter drills, and is also effective for making pick and chisel point bits for concrete breakers and similar tools. As in all Sullivan sharpeners, the "all-hammer" principle of upsetting and swaging the steel is employed, thus retaining the original quality of the steel and increasing its toughness and resistance to wear. Copies of this new bulletin will be sent upon request to the Sullivan Machinery Co., 400 North Michigan Ave., Chicago.

Road Graders.—Write to the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, for the latest folder describing Western graders and scarifiers. A line of graders adapted to all conditions is presented. A copy of the folder will be sent you upon request.

Wrenches. — The Heller "master-wrench" is described in a folder issued by the Heller Brothers, Co., Newark, N. J. This is a ratchet-action wrench made of chrome vanadium steel. The wrenches are made in sizes ranging from 6 to 14 in. in length, with smooth jaws for nuts and bolts and with pipe jaws for use on pipe. Write to the manufacturers for this circular.

Street Signals. — Write to the Rochester Street Signal Co., 400 Ward Building, Rochester, N. Y., for a folder describing "Monroe" and "Simplex" street signs. The "Monroe" unit is the only one in the market that employs no screws, nuts or bolts in the assembling. The fittings are made of aluminum. The sign plates are enameled. Inquiries are invited.

Rotary Soil Screens.—A recent folder describes four models of the Converse rotary soil screen, manufactured by the F. S. Converse Co., Inc., Johnson City, N. Y. Data are presented to prove that a rotary soil screen pays for itself in one season on an 18-hole golf course. The bulletin contains prices of complete units and accessories. The manufacturers will be glad to send you a copy.

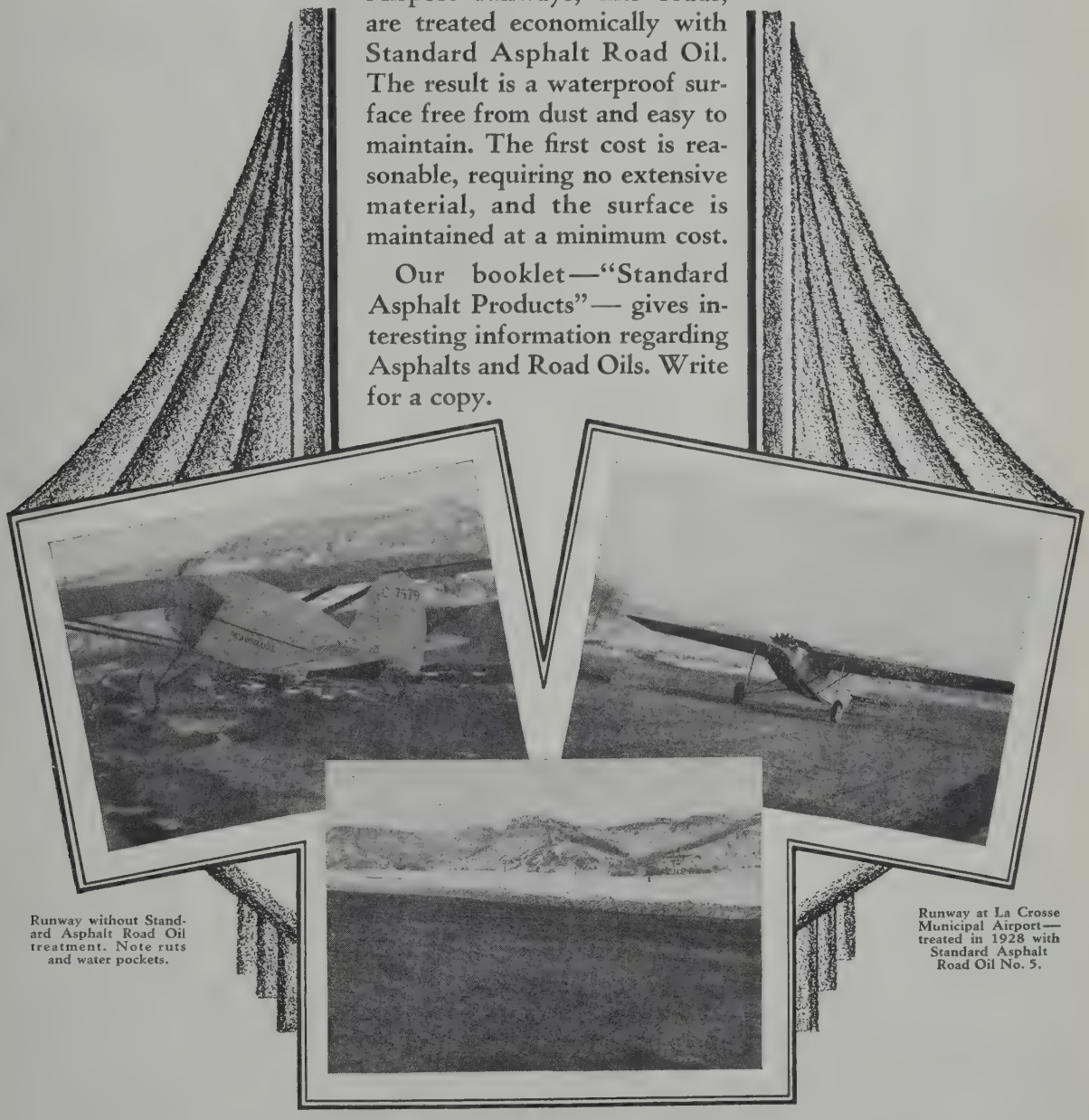
Good Roads Equipment. — Recent publications of the Good Roads Machinery Co. include booklets describing the Good Roads "motograder," the Good Roads senior roller, the Good Roads "autograder" and the Good Roads cold application oil distributors. These booklets contain detailed descriptions and specifications, along with photographs of the equipment in action. Write to the manufacturers for copies.

Wallace & Tiernan.—We have had the pleasure of receiving the latest Wallace & Tiernan bulletins, by title "Vacuum 'Type MSV' Chlorinator," "The Sanitation of Swimming Pools," "Chlorine in Sewage Purification," "Chlorination of Small Water Supplies" and "Wallace & Tiernan Highway Flashers." The use of chlorine in the disinfection of sewage is increasing, and a perusal of the Wallace & Tiernan bulletin dealing with this application of their products is recommended to all

AIRPORT RUNWAYS TREATED WITH STANDARD ASPHALT ROAD OIL

Airport runways, like roads, are treated economically with Standard Asphalt Road Oil. The result is a waterproof surface free from dust and easy to maintain. The first cost is reasonable, requiring no extensive material, and the surface is maintained at a minimum cost.

Our booklet—"Standard Asphalt Products"— gives interesting information regarding Asphalts and Road Oils. Write for a copy.



Runway without Standard Asphalt Road Oil treatment. Note ruts and water pockets.

Runway at La Crosse Municipal Airport—treated in 1928 with Standard Asphalt Road Oil No. 5.

Note smooth surface with complete absence of ruts, holes and water pockets.

STANDARD OIL COMPANY (*Indiana*)

General Offices: 910 S. Michigan Ave. CHICAGO, ILLINOIS

ILLINOIS	INDIANA	IOWA	MICHIGAN	WISCONSIN	MINNESOTA	MISSOURI
Chicago	Evansville	Davenport	Detroit	La Crosse	Duluth	Kansas City
Decatur	Indianapolis	Des Moines	Grand Rapids	Milwaukee	Mankato	St. Joseph
Joliet	South Bend	Mason City	Saginaw	Green Bay	Minneapolis	St. Louis
Peoria	KANSAS	Sioux City	S. DAKOTA		N. DAKOTA	
Quincy	Wichita		Huron		Fargo	Minot

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engineers and officials dealing with the and a perusal of the Wallace & Tiernan highway flashers are dry battery operated. The booklet includes specifications, drawings and typical layouts. A traffic engineer in the employ of the company is at the service of all municipalities having traffic problems. The Wallace & Tiernan publications are attractive typographically, delighting the eye at the same time as the mind is instructed by the subject-matter. Wallace & Tiernan Co., Inc., Newark, N. J., will be glad to send you copies.

Headley Grade Crossings.—Headley grade crossings and platforms for steam and electric railroads are described in a booklet issued by the Headley Good Roads Co., Franklin Trust Building, Philadelphia, Pa. "Headley No. 1" is an emulsified asphalt cement. Used to bond crushed stone or other suitable aggregate, it makes a safe, economical and durable crossing or platform. The booklet gives directions for mixing and applying. The manufacturers will be pleased to furnish you with a copy.

Core Drills.—Circular No. 29-B, issued by Sprague & Henwood, Inc., 221 West Olive St., Scranton, Pa., describes core drills and supplies manufactured by this firm. Of particular interest is a pavement core drill, arranged for mounting on a motor truck, making it convenient for the use of highway engineers. A copy of the circular will be sent upon request.

Industrial Engines.—Van Blerck industrial engines are described in a recent folder issued by the Light Manufacturing & Foundry Co., Pottstown, Pa. Pump installations powered by 4, 6 and 8-cylinder engines are illustrated. The manufacturers will be pleased to send you one of the folders, and they offer you the services of their engineering department.

Mine Scraper Hoist.—The American Hoist & Derrick Co. has just issued an illustrated folder which describes and illustrates their "American" mine scraper hoist. The hoist is operated by compressed air. The cylinders are of the 7 x 8 in. size. With an air pressure of 65 lb. at the throttle, the hoist has a single line pull of 4,300 lb. The hoist is very compact, being only 3 ft. high and 4 ft. 8 in. long. Some of the outstanding features of the hoist are piston valves, band-type frictions, cast-steel cut stub tooth gears and Alemite lubrication all over. For a copy of this pamphlet, address the American Hoist & Derrick Co., 63 South Robert St., St. Paul, Minn.

Toncan Iron.—The use of Toncan iron in perforated, corrugated iron underdrains is described in booklets recently published by the Canton Culvert & Silo Co., Canton, Ohio, and the Toncan Culvert Manufacturers' Association, Massilon, Ohio. Both booklets deal with the general problems of drainage, and contain technical and practical discussions of the design and application of Toncan copper molybdenum iron drains. Toncan iron is manufactured by the Central Alloy Steel Corp., Massilon, Ohio.

Mapping Instruments. — Miner & Leathermen topographic and traverse instruments for platting topographic field notes and traverses are described in a recent folder. It is stated that, with the aid of the topographic instrument, eleven and one-half days of field topography were platted and contours drawn, in eight and one-half hours. Write to Miner & Leatherman Co., 58 West Pearl St., Coldwater, Mich., for a copy.

Rotary Positive Blowers.—The P. H. & F. M. Roots Co., of Connersville, Ind., has just issued a new 16-page bulletin, No. 22-B1, on low-pressure type rotary positive blowers. The bulletin covers the new Roots modernized blowers, equipped with Timken, SKF or Hyatt bearings. The bulletin includes a dimensioned print, a table of sizes giving speeds, capacities and horsepowers at various pressures and a brief review of various types of pumping units. Bulletin 22-B1 replaces the former bulletin 1011 issued by this company, and is so constructed as to make it a valuable addition to the large Roots catalog covering pumps, meters and blowers. Write to the manufacturers for a copy.

Pioneer Gravel Equipment.—The Pioneer Gravel Equipment Mfg. Co., with offices in Minneapolis, Minn., will be pleased to send you literature and catalog describing the Pioneer gravel equipment line, which features portable screening, crushing and loading plants. The Pioneer line includes eleven sizes of crushing plants and five distinct sizes of gravel loading plants. In addition, the line includes draglines, shaker and revolving screens, belt conveyors, in three widths and several sizes of gravel storage bins.

Vertical Gas Engines.—Bulletin 782 of the Chicago Pneumatic Tool Co. describes the type RHG 75 vertical gas engines manufactured by this company. This is really a diesel engine adapted to the use of gas as a fuel. The booklet contains dimensioned drawings and photographs. The manufacturers will be glad to send you a copy. This company maintains an engineering department placed at the service of the customer to assist in solving difficulties and to make recommendations. Service branches are widely distributed and skilled service men are quickly available.

Bilge Pumps.—Bulletin B-3400 of the Yeomans Brothers Co., 1433 Dayton St., Chicago, presents the Yeomans line of heavy-duty bilge pumps. These pumps are built in single and duplex types and can be furnished with regular equipment or with a number of special features such as slow-speed motors, high water alarms, pipe casings for floats, automatic oil economizers, etc., which increase still further the reliability and durability of the machines. Drawings and data tables are included. Write to the manufacturer for a copy.

Servicised Products.—Catalog No. 12 of the Servicised Products Corp. has just come from the printer. This book deals with expansion joints in a rather brief but fairly complete manner, and treats exhaustively of other Servicised products of later development. Most important of these are fibrated asphalt planking, industrial flooring, rail filler, highway crossings and protection course for waterproofing. Readers interested in any way in waterproofing protection materials for use in connection with concrete construction for any purpose will find much that is interesting in the new Servicised catalog. Servicised expansion joints are treated completely in Servicised catalog No. 11, which is also available.

Arc Welding.—The very wide range of uses of electric arc welding in the maintenance field is shown pictorially in a publication recently released by the Westinghouse Electric & Manufacturing Co. Because of the great interest shown in the fabrication of structures by arc welding, the original application of the electric arc has been somewhat overlooked. This folder, entitled "Maintenance by the Electric Arc," is No. 7 of a series of folders on arc welding data. Any of these may be had upon request.

Manganese Steel.—Uses of "Amsco" manganese steel with "Fahralloy" products are described in a folder issued by the American Manganese Steel Co. "Fahralloy" is the name given to a series of alloys, at present fifteen in number, each having nickel and chromium in its analysis. "Fahralloy" products are adapted to uses where resistance to heat and corrosion is important. The American Manganese Steel Co. offers the cooperation of a department, directed by Dr. F. A. Fahrenwald, internationally known metallurgist, for the development of new and special metals to cope with unusual conditions. They will be glad to send you this bulletin upon application to any district sales office.

Water Wheels.—Bulletin W203 of the James Leffel & Co. is the first of a series being prepared on typical Leffel water wheel installations. This bulletin features the open penstock installation with submerged type gate operating mechanism. Inasmuch as the details in most water wheel installations are entirely covered by concrete or water, or both, the illustrations shown in this and succeeding bulletins will be of particular interest to users of water wheels. Write to the James Leffel Co., Springfield, Ohio, for a copy.

Power Graders.—A new folder from the W. A. Riddell Co., Bucyrus, Ohio, describes the Warco model "E" and "ER" power graders. Detail photographs and specifications are presented. The manufacturers will be pleased to send you a copy.

The longest highway bridge in the world

The San Francisco Toll Bridge is 7.1 miles long. The roadway is 27 feet between curbs. There were 346,016 lineal feet of piles, the largest 24 in. square, 105 feet long, and the shortest 16 in. square, 45 feet long. The entire construction cost $7,500,000.

This bridge was built by the Raymond Concrete Pile Co., New York. Consulting Engineers—Waddell & Hardesty, N. Y. Celite-for-Concrete was selected to insure workable uniform concrete which will resist the attack of sea water.

Completed 106 days ahead of schedule

625 tons of Celite were used to expedite the work on the San Mateo bridge connecting Oakland and San Francisco.

Because the bridge is located in salt water and was entirely precast twenty miles from the site, the greatest care was taken by the builders, Raymond Concrete Pile Co., to insure uniform, impervious, easy working concrete of high strength. Exhaustive studies were made, which resulted in the inclusion of Celite in all the concrete. Two pounds of Celite per bag of cement were used in the 4000 pound pile concrete; three pounds of Celite per bag of cement in the 2500 pound cap, beam and slab concrete, and five pounds of Celite per bag of cement in the railing and curbs.

The resulting concrete, all made at 4 to 5 in. slump, was transported in well filled buggies, without slopping, worked easily and thoroughly around the reinforcement, and came out of the forms with a smooth, impervious surface. By "fattening" the mix, Celite-for-Concrete improves workability more than would be obtained by increasing the Portland Cement content 25%.

The use of Celite produces concrete free from honeycombing with the surface so smooth and clean that decorative effects can be placed right over it without any other treatment. Celite obviates the temptation to use excess mixing water.

Hundreds of well known contractors and builders now use Celite in every yard of concrete they pour. Municipal, County, State and Government engineers in practically all sections of the country have approved or required its use.

With the aid of CELITE-for-Concrete

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Meter Boxes, Valve Housings, Etc.—A new ten page folder has just been received from H. W. Clark Company, Mattoon, Ill., illustrating and describing their gray iron products. The meter boxes are equipped with Wonder Lock, the key serving as handle of box, which cannot be removed without locking box. Products shown are: Meter boxes, box covers, wonder lock, valve boxes, valve housings, extension rings, repair lids, service box wrenches, etc. Illustrations clearly bring out the advantages of these products.

Airports.—"Getting on the Air Map with Caterpillar" is the title of a very attractive booklet issued by the Caterpillar Tractor Company, San Leandro, Cal. Booklet states: "There are more than 1,000 airports in the U. S.—some still in the making. The country needs 10,000." Booklet gives much interesting information concerning what is being done in various parts of the country to meet this need. Send for a copy, kindly mentioning our magazine.

Foundries.—Three folders, of special interest to foundry men, have just been issued by the Link-Belt Company, 910 S. Michigan Avenue, Chicago. These booklets describe the Continuous Malleable Foundry of the Saginaw Malleable Iron Division of General Motors Corporation; the three foundries of the American Manganese Steel Company, and the Link-Belt Vibrating Screen. The Link-Belt Company will be pleased to send copies upon request. If writing kindly mention our magazine.

Sluice Gates.—W. C. A. No. 32 issued by Rodney Hunt Machine Company, 101 Lake Street, Orange, Mass., gives some valuable information on sluice gates and hoisting equipment. This company, manufacturers of water controlling apparatus, will be pleased to give you detailed information about their hand operated, motor operated and hydraulic cylinder operated hoists and stands and accessories for all types of sluice gates, wide bronze facings, eliminating corrosion.

Concrete Pipe.—A very attractive book, giving much useful information on the sanitary engineering field as it applies to concrete pipe, is that issued by the Independent Concrete Pipe Company of Indianapolis, Ind. It is printed on heavy enamel paper, with many clear and comprehensive illustrations and is stitched into a heavy cardboard cover of pleasing appearance, putting the information into permanent form. In addition to a short history of the field, it gives the design, specifications and manufacturing methods of Independent Reinforced Concrete Pipe. The illustrations show manufacture and installations in places described.

Reinforced Concrete Pipe.—A pamphlet issued by the Lock Joint Pipe Company of Ampere, N. J., gives complete description and illustrations of reinforced concrete pressure pipe, which is of three kinds, poured pipe, cylinder pipe and centrifugal pipe and with expansion joints of two types, "Lead and Iron Joint" and "Lead and Steel Joint." All forms are steel held by cast-iron rings, insuring great accuracy and especial smoothness. In addition to photographic illustrations booklet contains several blue print drawings. Copies may be secured from eastern office, or from Chicago branch at 110 S. Dearborn Street.

Wrought Iron.—The A. M. Byers Company, Pittsburgh, Pa., has issued in handsome pamphlet form a reprint from World's Work "The New Story of Ancient Wrought Iron," by Donald Wilhelm. This is a story of the making of wrought iron from the earliest record down to the Aston Process put into practice last year by the A. M. Byers Company at their plant near Warren, O., and for which a new plant is being constructed at Ambridge, Pa. The manufacturer will no doubt be pleased to send copy of this reprint to anyone interested.

Street Department Supplies.—Catalog No. 31 issued by the Safety Gas Main Stopper Company, 523 Atlantic Avenue, Brooklyn, N. Y., bound in loose leaf type, illustrates and describes a long list of products including gas main bags, main plugs, stoppers, gauges, pipe cleaning brushes, cylindrical stoppers for water mains, etc. The new gauge and gas bag valve combination eliminates guess work in the use of inflatable bags and stoppers on which a pump is used. The pressure gauge shows when the pressure is sufficient and whether the bag is holding or losing air.

Mixer.—Koehring Company, Milwaukee, Wis., will be pleased to send you a special circular on the Koehring Weigh Mix, a standard heavy duty mixer with weighing batch hopper and water tank mounted on an auxiliary frame. All operations are controlled from platform, all aggregate is weighed in one hopper and water weighed on same beam.

Deep Well Power Plant.—The United Iron Works, Inc., Tulsa, Okla., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems.

Water Meters.—For literature on water meter setting and testing equipment write to the Ford Meter Box Company, Wabash, Ind. Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently.

Sewer Cleaning Machine and Rods.—W. H. Stewart, P. O. Box 581, Jacksonville, Fla., and branches in St. Louis and Boston, as well as factory in Walkerville, Ontario, will be pleased to send literature describing his sewer cleaning machine and conduit rods. Folder describes the hand power machine or the Wonder Bucket equipment. Sewer rods are also illustrated and described, and a list of hand tools for use with sewer rods. This sewer cleaning device will remove anything possible to get into a sewer and clean thoroughly with the least possible difficulty.

Zeolite.—The Zeolite Chemical Company, 140 Cedar Street, New York City, will be pleased to send you "Softening Municipal Water Supplies by the Use of Zeolite," a booklet which describes green sand, a natural base exchange Zeolite mineral, used for water softening. Much interesting information is given.

Stillson Wrenches.—Sando Original and Moroco Popular Stillson wrenches, formerly made by the Moore Drop Forging Co. of Springfield, Mass., are now manufactured by the Trimont Manufacturing Company, 55 Amory Street, Roxbury, Boston, Mass. The Sando has a drop forged handle and jaw, and is scientifically hardened for maximum strength. Handle is made in wood or steel type. Both Sando and Moroco are described and sizes and prices given in booklet which will be sent by manufacturer upon request.

Fire Hydrants and Valves.—The Mathews Fire Hydrants built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia, Pa. A broken Mathews can be replaced is a very few minutes and without excavation or breaking up the pavement. Manufacturer will be pleased to send you full information.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., have had reprints made of a paper by Harry F. Ferguson (chief sanitary engineer, division of sanitary engineering, department of public health, Springfield, Ill.), and Clarence W. Klassen (assistant sanitary engineer, division of sanitary engineering, department of public health, Springfield), and appearing in the January issue of the Journal of the American Water Works Association. The title of the paper is "Are Your Wells and Reservoirs Contaminated?" The report treats of sources and reasons for water contamination, and states: "If owners of public water supplies overlook * * * or permit * * * contamination to continue * * * such owners * * * would be liable for damages for any illness * * * in accordance with recent court decisions." Wallace & Tiernan Co., Inc., will be pleased to send you a copy of this reprint, together with their technical bulletins describing their Chlorinators. Chlorination in the instances cited in the report would have protected the public health. Write for this literature.

Traffic Signals.—Catalog No. 129 has been issued by the Interflash Signal Corporation, 120 Broadway, New York City, describing Interflash "U. S. Standard" road signs and beacon signals for

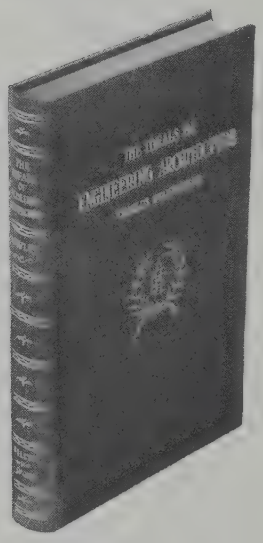
ENGINEERING
Set to the Music of
ARCHITECTURE

For the engineer whose soul is not deaf to the harmonies, the spacious rhythms, and the eloquence of architecture,—For the architect who is sensitive to the new demands of modern engineering structures, Charles Evan Fowler has struck an inspiring note in this new book. Progressive men in both professions must keep pace with the trends of development. Their progress, reputation, prestige depend on such alertness.

In "The Ideals of Engineering Architecture" the author gives a new vision of artistic design in Bridges, Buildings, Dams, Lighthouses, Sea Walls, Tunnel Portals, Retaining Walls, Piers, and kindred Engineering Structures. Fundamental design more than applied ornamentation is the requirement and will, in this phase of our civilization, become increasingly necessary.

Read this book and catch its spirit. We think it will color your future work. By our offer you may judge for yourself without cost.

—to the Increasing Profit of Both Professions



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The author of this new book is highly qualified to speak with authority. Charles Evan Fowler, Consulting Civil Engineer, is a member of the American Society of Civil Engineers, Engineering Institute of Canada, Society of Terminal Engineers, a special lecturer for the University of Washington and author of many other papers and texts.

The Gillette Publishing Co., 221 E. 20th Street., Chicago, Ill.
Technical Publishers

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Please send a copy of "The Ideals of Engineering Architecture," by Fowler. I agree to remit $4 plus postage by check or money order or return the book within 10 days.

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The Ideals of Engineering Architecture

day and night service. Catalog describes the various types illustrated for use on highway and at street intersections where only a warning or cautionary signal is required. These are operated by either self-contained acetylene gas flushing equipment or direct from electric power lines. If interested in all-electric type of control signals ask for Catalog No. 229. For navigation lights for lighthouses, towers, buoys, wharves, bridges, etc., write for Catalog No. 329.

Chemicals.—The Kalbfleisch Corporation, 200 5th Avenue, New York, will be pleased to send you booklet on this subject in its connection with industries. The booklet is very handsome appearing, containing 84 pages, the first part being devoted to the sources, manufacture and uses of chemicals, together with a long list manufactured by the company—industrial and miscellaneous chemicals. The tables at the back of the book give atomic weights, corrections for temperatures and many other tables to serve the chemical user.

Hot Process Water Softener.—A new 12 page catalog in loose leaf style, Bulletin No. 5049, has just been issued by the Graver Corporation, East Chicago, Ind., describing their hot process water softener. Catalog gives views of installations and the component part of the softener. Booklet also contains tables showing savings made by use of softener. An extension to the front cover printed in colors enables the reader to refer to it as he reads the text of the booklet. An informative and attractive bulletin.

Paint Spray Brush.—Simons Paint Spray Brush Co. of Dayton, O., have issued a little booklet describing their paint spray brush and electric and gasoline air compressors to use with it. Containers, fittings, etc., are described and illustrations show the brush at work. For difficult painting jobs, such as large steel water towers, highway bridges, etc., this equipment saves in labor and paint. Ask for a copy of booklet G.

Tractors.—Catalog B-100 issued by Foote Bros. Gear & Machine Co., 215 N. Curtis Street, Chicago, covers all three models of the Bates "Steel Mule" tractor, 30-40-80. The Bates "Steel Mule" is easy to handle, has few wearing parts, and powered by Waukesha motor, it operates at high efficiency at all operating speeds. The crawlers run full length of tractor so it cannot nose into a bank with its radiator. Equipped throughout with IXL-ITE tool hard gears. Booklet fully illustrates, describes and gives specifications of all models.

Fire Hydrants, Gate Valves, Boxes, Indicator Posts, Etc.—A very attractive folder has been issued by the Iowa Valve Company, 701 Hubbell Building, Des Moines, Ia., giving the latest improvements on the products of this company, whose factory is located at Oskaloosa, Ia. Particular attention is called to the many improvements in the fire hydrant, such as the positive mechanical drip valve, bronze working parts, rubber mounted valve, new and improved adjusting feature which insures main valve in line with seat, all working parts removable through top of standpipe without use of special wrench or tripod, unrestricted water flow, delivering full pressure and simple construction. Folder gives description and illustration of fire hydrant and many of the other products of the company.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., manufacturers of chlorine control apparatus, will be pleased to send you full information concerning their MSP Chlorinator. This equipment in duplicate is protecting hundreds of small cities by safeguarding their water supply. Records of cities where this method is in use will be furnished as well as much interesting information concerning sterilization of water.

Centrifugal Pumps.—Booklet W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., contains much interesting information concerning their geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. Pumps for general water service, power plant service, sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. Write for literature.

Planning a Waterworks System.—This is the title of a little booklet which the Cast Iron Research Association, Peoples Gas Building, Chicago, will be pleased to send you upon request. No community of 500 persons can afford to continue without a waterworks system, and many smaller towns have excellent systems. Booklet discusses Engaging the Engineer; Plans; Source of Supply; Estimating Requirements; Pumping System; Duplicate Equipment; Storage Supply; Distribution; Pipe; Hydrants; Records; etc.

Sewage Treatment Plants.—Bulletin No. 101, dated February, 1929, has just been received from the Pacific Flush Tank Company, 4241 Ravenswood Avenue, Chicago, or 9 Park Place, New York, describing the Sprinkling Filter Design using the Twin Dosing Tank Equipment. It is a very comprehensive presentation of this type of sewage treatment, and contains many detailed illustrations and data concerning large plants in use throughout the country. There are several pages of design data for single and twin tanks with percentage tables. There are also cuts and descriptions of dosing tank counter, nozzles and Marley Tees.

Chlorinizer.—Bulletin No. 20 put out by the Paradon Manufacturing Co., Arlington, N. J., gives full description of Paradon Chlorinizer. Chlorinization is in universal use for sterilization of water supplies, sanitation of swimming pools and for the disinfection of sewage. Operation, advantages, capacity, types of chlorinizers, applicability and specifications are all given in bulletin, and a list of a few typical installations is also included, regarding the Paradon equipment, a chlorinating device for small water supplies, swimming pools, and sewage plants such as in use in small municipalities, factories, camps, estates, country clubs, hotels, etc.

Cast Iron Pipe.—Write to the Central Foundry Company, 420 Lexington Avenue, New York City, for information concerning the cast iron pipe with machined hub and spigot ends, all cast iron, eliminating calking or use of any jointing material. No tool needed but a wrench.

Manhole and Catchbasin Covers.—Wm. E. Dee & Company, 30 North La Salle Street, Chicago, will be pleased to send prices and full particulars concerning their D & D Safety Cover. They guarantee this cover not to rattle or dish.

Diesel Engines.—A bulletin from the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., has been issued describing the diesel power plant at Freeport, L. I., N. Y., where the 6th Busch-Sulzer Diesel—a 1,500 B. hp.—1,050 kw. unit, has just been purchased, making this the largest municipal Diesel plant in the United States, according to statement contained in folder. Their Diesel engines are built in 2-cycle and 4-cycle types, stationary and marine.

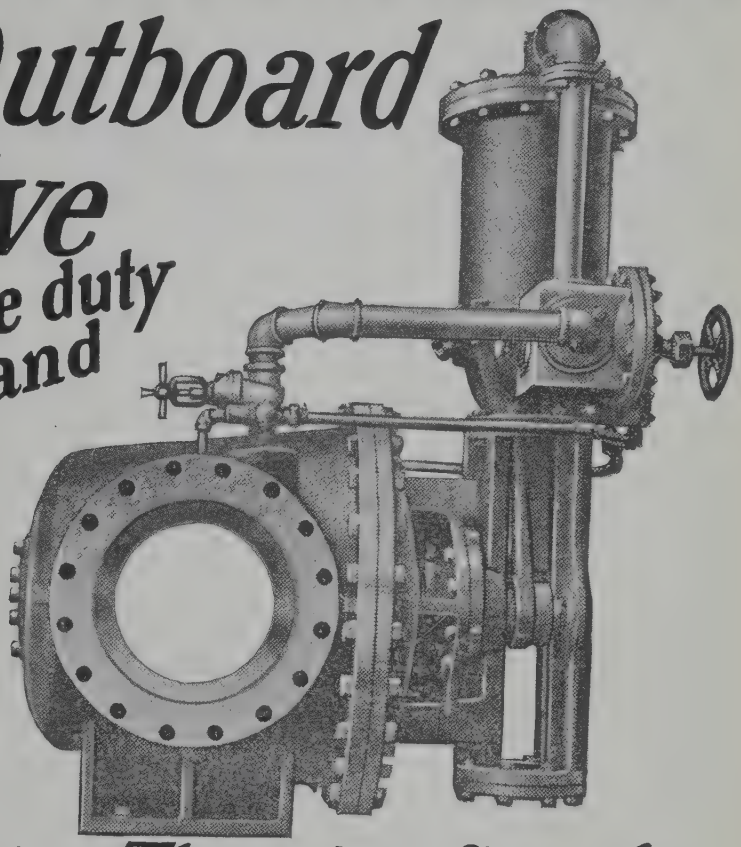
Steel Storage Tanks.—Municipal Catalog No. 2 issued by the Pittsburgh-Des Moines Steel Company, 4 Neville Island, Pittsburgh, Pa., give description and information regarding the product of this company for taking care of water consumption during the peak hours and insures a constant pressure at all times. Use of these tanks eliminate fire hazards when repairs are being made at the pumping plant. Information will be furnished concerning complete water works system, pipe lines, reservoirs, filtration, purification, etc.

Fact Book of Steel Construction.—The American Institute of Steel Construction, Inc., 285 Madison Avenue, New York City, has just published a Fact Book which lists the steel fabricators of the United States, Canada, Mexico and Hawaii. It presents in chart and tables the statistics of steel, fabrication and construction work. In addition to presenting data relating to the tallest and largest buildings in the United States it also publishes for the first time the most complete list of steel bridges in the U. S. This book has been brought out because of the now general use of the skyscraper throughout the land and the widespread interest in the fabrication of structural steel.

Porous Concrete Well.—F. Thorpe, 1932 Illinois Avenue, East St. Louis, Ill., will be pleased to send you folder

The New Automatic Cone Outboard Type Valve

Does the double duty of both a Stop and Check Valve



In Operation They Are Simple

The new Automatic Cone Outboard Type Valve has been a sensation ever since it was introduced a few months ago. Its enthusiastic endorsement by operating engineers has been far beyond our fondest hopes.

Automatic Cone Valves are designed that they do the double duty of both a stop and check valve.

When Automatic Cone Valves are in full open position, the waterway is similar to a piece of pipe and reduces frictional resistance to a minimum. The question of friction plays a very important part in the design and layout of plants and pipe lines; wherever obstructions are eliminated the increase in pressure can be evaluated on a dollar and cents basis which reflects itself into increased efficiency.

All the operating mechanism is "outboard" and can be inspected without interfering with operating. In fact, every part of the hydraulic mechanism can be removed and replaced without shutting down the pipe line.

The accompanying picture shows the automatic cone valve which is composed of two distinct mechanisms. The hydraulically operated cone valve and the control mechanism which properly times the opening and closing of the valve eliminate shock and water hammer. Cone valves are made for electrical, manual or hydraulic operation. All automatic cone valves are hydraulically operated. Manually operated and electrically operated cone valves are very adaptable for use as stop valves controlling distribution systems where pipe diameters are of large size. Write for further details.

AUTOMATIC CONE VALVE CO.
Builders Building, Chicago, Ill.

AUTOMATIC CONE VALVES

describing this type of well and will furnish a list of references. Some of the outstanding features are length of life, elimination of repair or maintenance costs, satisfied owners, etc.

Toledo Torch.—The new Toledo Torch "Champion" is the product of the Toledo Pressed Steel Co., Toledo, O. Write to the manufacturer for full information as to construction, service and costs.

Steel Sheet Piling.—Address Wemlinger, Inc., Singer Building, New York, or 228 North La Salle Street, Chicago, for information in regard to buying or renting steel sheet piling.

Clay Products.—Wm. E. Dee Clay Mfg. Co., 30 N. La Salle Street, Chicago, manufacturers of standard and double strength sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick, will be pleased to send you full information on any or all of these products.

Sewer Flusher.—Petersen's Hydraulic Flusher Company, 277 First Avenue, Milwaukee, Wis., will be pleased to send you literature illustrating and fully describing their sewer and pipe flushers. It is made in three styles of heavy grade canvas and waterproof tubing. A labor saving tool for city, contractors and manufacturers, and an economical way of clearing sewers.

Cast Iron Pipe.—An attractive folder from the McWane Cast Iron Pipe Company of Birmingham, Ala., and Provo, Utah, shows many successful uses for this pipe. It is used in parks for feeding sprinkling systems, by railroads in yards for water, air and low-pressure steam lines, etc., all of the 2-in. size. It is also made in 4, 6, 8, 10 and 12-in. sizes. Manufacturer will be pleased to send literature illustrating and describing pipe in all sizes for all uses.

Pumps.—Bulletin P-29 issued by the Jaeger Machine Company, Columbus, O., gives illustrations, specifications and full description of diaphragm, plunger type, lift and force centrifugals. The Speed Boy is a 4-cycle high speed engine with foot starter coupled with nonclogging big volume pump with Jaeger open type brass impeller that handles 25 per cent to 28 per cent solid matter such as sand, mud or solid stones. Write for this bulletin.

Cast Iron Pipe.—A very attractive booklet called "Small Diameter Cast Iron Pipe" has just been issued bearing the name of the American Cast Iron Pipe Co., Birmingham, Ala. Types of small diameter pipe described in booklet include: Simplex Prepared Joint Cast Iron Pipe; Two-Inch Bell-and-Spigot Cast Iron Pipe; Two-Inch Prepared Joint Cast Iron Pipe; Threaded-End Cast Iron Pipe; Doublex Simplex Cast Iron Pipe; Flanged Cast Iron Pipe; Cast Iron Pipe for Vitaulic Joints; Bronze Welded Joints and Small Diameter Cement Lined Pipe. Booklet is printed on heavy enamel paper and has an extra heavy cover.

Calatom.—An admixture for concrete which is mined, milled and refined exclusively by Monterey Products Company, Monterey, Cal., and distributed east of the Rocky Mountains by Tamms Silica Company. Calatom is a low water absorption diatomaceous earth for workability and waterproof concrete. Write to the Tamms Silica Company, Stock Exchange Building, Chicago, Ill., for literature giving complete information concerning this powered admixture.

Deep Well Water Systems, Etc.—Alamo Engine Company, Hillsdale, Mich., has issued a very attractive 60 page booklet in loose leaf style, describing the use of Alamo-Dorward Rotary Power Head, for operating deep well and other types of reciprocating plunger pumps. Booklet contains cross sectional drawings, explanation of capacity table captions with several pages of capacity tables.

Meter Boxes, Couplings, Testers, Service Boxes, Etc.—Catalog No. 24 issued by H. W. Clark Company, Mattoon, Ill., gives full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for accessibility for repair work or replacements. Full particulars furnished on all equipment.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Centrifugal Pumps.—The Byron Jackson Pump Co., Berkeley, Cal., will be pleased to send you literature giving full information concerning centrifugal pumps for any purpose. They have branch offices in San Francisco, Chicago and New York, as well as Portland, Salt Lake, Dallas and Phoenix. Their deep well turbines make available the water from deep stream sources. Write for particulars.

Cast Iron Pipe.—"Spi-Cor" is the title of a little booklet issued by the American Casting Company, Birmingham, telling the story of a new era in "culverting." It gives much interesting information in condensed form on spiral corrugated cast iron pipe. If writing for booklet, kindly give the name of our publication.

Paved Invert Culverts.—"Paving the Culvert to Combat Erosion" is the title of a comprehensive pamphlet issued by the Armco Culvert Mfrs. Association, Middletown, O. This product is designed for use where culverts carry highly sedimentary streams, on steep grades, in mountainous country, storm sewers, etc. The booklet illustrates in detail the paved invert and describes tests applied in developing it. The culvert must be made to withstand hydraulic traffic within and vehicular traffic from above. The booklet describes the Armco system. Kindly give the name of our publication if writing manufacturer for literature.

Excavator.—Write to the Bucyrus-Erie Company, South Milwaukee, Wis., or Erie, Pa., for bulletin on their D-2 Diesel Drag-Shovel. This shovel is built for the hardest work at a minimum cost. Easily convertible to clamshell-crane, shovel or dragline. Manufacturer will be pleased to furnish you with performance records of this equipment.

Sludge Removal.—The Link-Belt sludge collector is recommended by the manufacturer for its sturdy mechanism and reliability in removing sludge from sedimentation tank. An excess of accumulation of sludge will not slow down or stop operation. For complete information concerning this or other sewage treatment plant equipment, write to the Link-Belt Co., 300 W. Pershing Road, Chicago. Kindly mention our magazine.

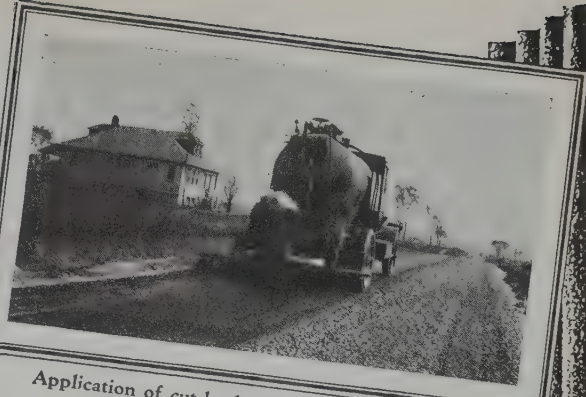
"The Cleaning of Water Mains."—This is the title of a booklet issued by the National Water Main Cleaning Company, 32 Church St., New York, describing the method so successfully used by them for the past twenty years. Write for a copy, giving the name of our magazine.

Well Systems.—Write to Layne & Bowler, Inc., Memphis, Tenn., or any of their representatives located in all the principal cities, for information about the Layne Water Well Systems. They will be pleased to give you the benefit of their long years of experience in this field.

Centrifugal Pumps.—For a complete catalog on this equipment write to the DeLaval Steam Turbine Co., Trenton, N. J., asking for Catalog B. This is a very handsome 72-page catalog, discussing single stage and multistage pumps, for general water service, power plant service, including boiler feeding, condenser circulating and hot-well service, water works service, including main pumping units and booster, filtration and flushing service. Pumps for sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. The catalog is beautifully illustrated and gives cross sectional drawings showing details of pumps. There is a section on manufacturing methods and materials, and one on testing, also just what information should be furnished in seeking plant for individual requirements. Manufacturer will be pleased to send you a copy of this informative book. Kindly mention our magazine.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.

Application of cut back asphalt as a primer coat on existing stone base.



Application of cut back asphalt on stone which has been spread on the roadway.

Many Towns Are Resurfacing Their Streets in This Manner—

BY the use of cut back asphalt. In Clarenden Hills, a suburb of Chicago, over seven miles of streets have been resurfaced with Stanolind Cut-Back Asphalt—resulting in smooth, attractive roadways which are easy to ride on.

The retread method was used, requiring only ordinary available equipment. This method of construction is economical and is suitable for nearly all types of roadways.

Mixing and surfacing of cut back asphalt and stone on the roadway with a blade grader.

Final application of cut back asphalt before completing roadway. Note the application of ¼ inch keystone on the surface.

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DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Just to Remind You!

The space devoted to this department is about equally divided between stories of manufacturers and distributors. Let us introduce you personally to our readers. In the technical pages of the magazines they read about your product, and how it is aiding in the progress and development in this age of scientific and mechanical accomplishment. Your organization stories and personal items appearing in Distributor News tell our readers how and where these devices are distributed for their use. We are always glad to hear from you. We like to look at pictures,—so do our readers. Send us some about yourselves. Address: Distributor News, Gillette Publishing Company, 221 East 20th St., Chicago.

United Tractor and Equipment Corp. Hold Annual Directors' Meeting

At the meeting held in Milwaukee, June 19th, Milton W. Anderson was re-elected president of the United Tractor and Equipment Corporation, according to announcement recently issued. W. B. May, president of W. B. May, Inc., Buffalo, N. Y., was elected vice-president; E. R. Wehr, vice-president of the Wehr Company, Milwaukee, secretary-treasurer, and H. T. Enns, Jr., of Chicago, assistant secretary-treasurer.

The United Tractor Corporation was organized for the purpose of developing a cooperative manufacturing and marketing plan for a full line of equipment to be used with the United Tractor to be built by the Allis-Chalmers Company. Stockholders and directors from twenty-two states and Canada met in Milwaukee, for the purpose of inspecting the various products of the United line, and the newly completed special factory in which Allis-Chalmers Company will begin increased quantity production of the Tractor on August 1st.

Mr. Anderson, who came east from the equipment distribution field in California about a year ago to organize the "nation-wide, full line movement" states that applications for membership are steadily adding to the organization, and that developments have demonstrated the soundness of the plan, which is backed by the $125,000,000 joint assets of the members. Forty manufacturers and distributors of tractors, and industrial equipment, make up the membership, which resulted from Ford's abandonment of the tractor field in this country.

When the manufacturers and distributors met in Milwaukee, demonstrations of the various United appliances were given at the proving grounds of the Trackson Company. There they viewed the Allis-Chalmers Company operate the United tractor; the crawler attachment for the United made by the Trackson Company; the road grader of the Wehr Company and other equally interesting pieces of equipment, and expressed themselves as greatly pleased with the outlook.

Directors at the stockholders' meeting were: H. C. Merritt, Allis-Chalmers; Walter H. Stiemke, Trackson Company, and E. R. Wehr, of Milwaukee; Arthur S. Hughes, the Hughes-Keenan Co., Mansfield, Ohio; Dunbar Abston, Dealers' Equipment Co., Memphis, Tennessee; A. W. Logan, Motor Power Equipment Co., St. Paul, Minnesota; C. V. Ruble, Universal Equipment Co., Kansas City, Missouri; W. B. May, W. B. May, Inc., Buffalo, N. Y., and Milton W. Anderson.

Announcement

M. P. Hatcher and Albert E. Pugh announce the opening of the Water and Sewage Laboratories, 1334 Oak Street, Kansas City, Missouri, where they will conduct a general laboratory practice in the field of water purification and sewage treatment. The scope of their activities will include commercial analyses, industrial water and trade waste problems and general supervision of water or sewage plant operation.

M. P. Hatcher will continue in his present capacity, as associate engineer, with the Burns and McDonnell Engineering Company, according to announcement.

A. W. Newby Made President of Huber Manufacturing Co.

A recent announcement from the Huber Manufacturing Co. states that Mr. A. W. Newby, former vice-president of the company, has been elected president and general manager, to succeed Mr. S. E. Barlow, resigned. Mr. Barlow was elected chairman of the board.

The Huber Manufacturing Co., located at Marion, O., is known to the trade as maker of Huber four-cylinder motor roller and Huber road tractors.

Interior View H. O. Penn Company, New York
Partial view of store room of H. O. Penn Machinery Company New York City, distributors of construction machinery, showing mixers and tractors, with saw-rig in the foreground. Warehouse and offices at 140th St. and East River.

When You Come To The River

You Must Know Highway BRIDGE Engineering to Carry On Profitably

To the aid of the highway engineer, county engineer and municipal engineer comes this new and straightforward treatise, "Economics of Highway Bridge Types." It fits the needs of the practicing engineer who, when his road must span a stream, meets a specialist's problem.

Such an engineer makes no pretense of being a bridge engineer. Oftentimes he does not at first grasp the scope of the problem. For it is not the problem of building a bridge, but one of *economic analysis and type selection.* Millions of dollars have been wasted through improper type adaptations, unwarranted first costs and needless maintenance expense. It is on this point that this author so squarely places his finger. Squarely and with immeasurable helpfulness. Necessarily the question of costs is exhaustively treated, and this feature of the book alone earns it a place in every civil engineer's library. Cost curves, quantitative and qualitative analyses and such factors as flood insurance, rental values, etc., bring this work a scope that assures its value. Send for a copy, read it, —then decide whether to keep it.

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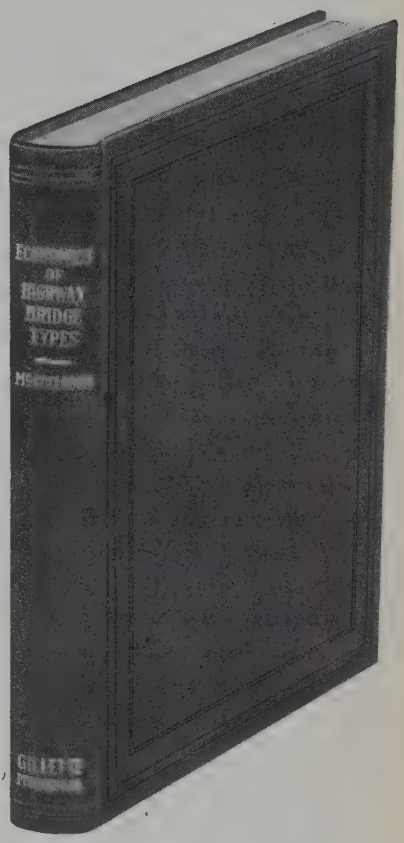

Read the Table of Contents, then clip and Mail the Coupon

These Are the Chapter Headings: General Factors Controlling Types Selection—Fundamentals of Economic Analysis—Bridge Types—General Discussion and First Cost Data—Short Span Superstructures—Longer Span Superstructures — Substructure Types — Miscellaneous Types and Cost Data—Renewal and Maintenance Costs—Unit Costs—Illustrative Problems in Type Selection.

by

C. B. McCullough, B. S., LL. B., C. E.

Bridge Engineer, Oregon State Highway Commission; Member Oregon Bar; Member A. S. C. E.; Special Lecturer, Oregon State Colleg

Gillette Publishing Co., 221 East 20th St., Chicago, Ill.

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Please send a copy of the "Economics of Highway Bridge Types," by McCullough. I agree to remit $5 (check or money order) plus postage or return the book within 10 days.

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WW-7-29

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for Northern California territory. Now stocking equipment for several well known machinery manufacturers.

Man experienced in selling road building machinery to state highway departments, contractors, county and city officials, would like to make connection as district representative or branch manager. Located in Ohio, but would consider other territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Civil engineer located in Porto Rico would like to hear from manufacturers desiring sole representation for their products in Porto Rico, Santo Domingo and Venezuela. Machinery for highway construction, purification plants, steel for buildings or bridges or other building materials and contractors' equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the Southwest and Middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Manufacturer of complete line of Construction Equipment, mixers, saw rigs, plaster and mortar mixers and pumps, has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

"If it saves only one contractor and his family from the pangs of bankruptcy.... this book will have been more than worth while."

That is what Mr. Frank L. Connor modestly says of his own book, "Labor Costs of Construction". You will agree, when you read this frank digest of practical contractor's detailed costs, that not one, but many in the building field can avert bankruptcy by comparing costs and checking up carefully on differences. Hundreds can turn losses to profits by the same means.

Think what it would mean to you if a competitor would consent to lay bare his costs to you, on any class of work you might name.

Frank L. Connor, General Contractor, has summarized years of experience with building labor in straightforward paragraphs and pages full of meat. Where in his own work he has saved labor and money by a unique method, he tells about it. Where one material requires less handling than another, comparative costs are given. These pages stimulate thought and as you think, you become a better estimator, contractor, superintendent, or foreman.

We will lend you a copy for 5 days. Just read our offer on the coupon below.

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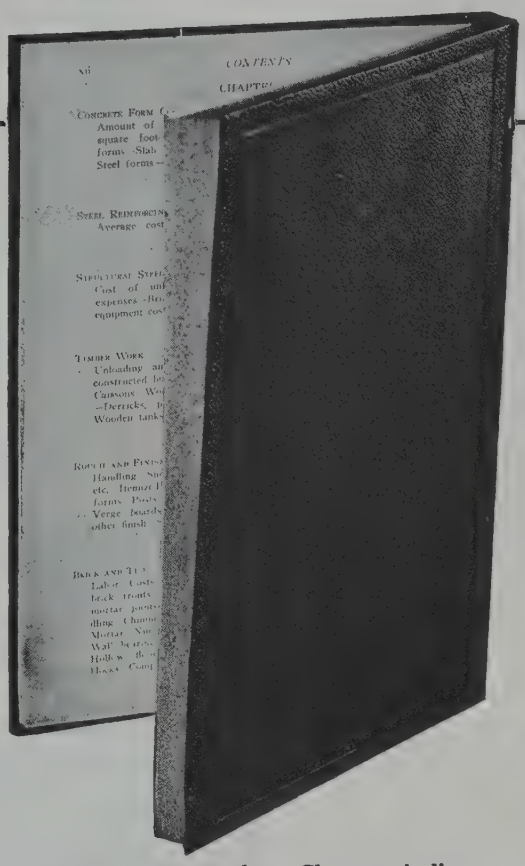

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I ask the Gillette Publishing Co. to send me for 5 days free Frank L. Connor's "Labor Costs of Construction" that I may compare it with my own experience. I will, on the sixth day, remit only $3 or return the book.

Name_____

Company_____

Address_____

City_____ State_____

WW-7-29

Westinghouse Elects Merrick President

Announcement has been made of the election of F. R. Merrick to the presidency of the Westinghouse Electric and Manufacturing Company, succeeding E. M. Herr, who has held the position since 1911. According to the announcement of A. W. Robertson, chairman,

F. A. Merrick, president Westinghouse Electric & Mfg. Company

Mr. Herr's resignation was accepted to permit him to take an extended vacation. He has been elected vice-chairman of the Board of Directors.

Mr. Merrick, a graduate of Lehigh University, became connected with the Westinghouse Company when it acquired the Steel Motors Company, with whom he held the position of manager and chief engineer, having entered the employ of Steel Motors soon after his graduation from college. At the time of his election to the presidency of Westinghouse, he was vice-president and general manager.

At the time Mr. Merrick became identified with Westinghouse, he was selected to prepare plans for a plant in Canada and upon formation of the Canadian Westinghouse Company, Ltd., in 1903, he was sent to the Dominion as superintendent of the company, becoming in turn manager of the works and vice-president and general manager of the Canadian Company.

During the World War, Mr. Merrick was assigned to organize the operations of the New England Westinghouse Company located in Chicopee Falls, Mass., to manufacture rifles for the Russian government, and later on to furnish American war material. This required reorganization and factory re-equipment, and under these conditions Mr. Merrick completed an order for 60,000 Browning machine guns within 11 months after operations were begun.

For two years after the war Mr. Merrick was located in London, as special representative of Westinghouse International, returning again to Canada, and in 1925 was made vice-president and general manager of the Westinghouse Electric and Manufacturing Company, with headquarters in East Pittsburgh. At the same time he was elected a director of the company. His headquarters are now located in Pittsburgh.

At Your Service

Wallace & Tiernan Company, Inc., of Newark, New Jersey, manufacturers of chlorine control apparatus, who "consider every sale an obligation for service" have recently announced a reorganization of their field staff in the United States and Canada. They have established a sales and service office within a few hours' travel from every installation, and have issued a charted map showing the location of the factory, and all division and district headquarters. To cover the territory they make use of air, water, rail and truck as methods of transportation.

Ryan Sales Co. to Represent Yeomans Bros. in Tenn.

Announcement has been made by Yeomans Brothers, manufacturers of sewage ejectors, pumping machinery and rotary air compressors, of the appointment of the Ryan Sales Company, 1122-24 Stahlman Building, Nashville, Tennessee, to represent them in that state east of the Tennessee River.

The Ryan Company will handle the complete Yeomans line, which includes general service, water supply, bilge and condensation return pumps, rotary air compressors and sewage ejectors. Yeomans Brothers Company are located at 1433 Dayton Street, Chicago.

Introducing Chester A. Phillips and Company, Chicago

An announcement has recently been received to the effect that Mr. Chester A. Phillips, formerly associated with the Osgood Company has established the firm of Chester A. Phillips and Company for the purpose of handling contractors' marine, quarry, railroad and industrial equipment. Offices have been opened at 37 West Van Buren Street. Yards address is 1850 South Kostner Avenue.

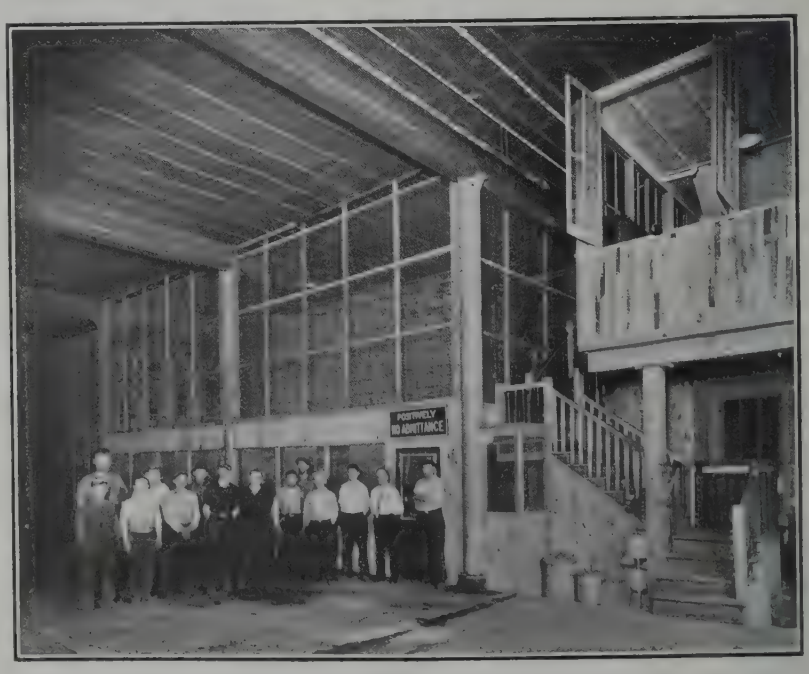
Linde Air Products Now Operating Louisville Plant

The Linde Air Products Company have commenced operations at their new plant located at 2603 Floyd Street, Louisville, Kentucky, producing oxygen to supply the local demand, according to a recent announcement.

Mr. Frye is superintendent of the new plant and W. L. Potts, whose headquarters are at the Cincinnati plant, is district superintendent.

Power Plant Supply Occupy Quarters in New Fisher Building

The Power Plant Supply Company, one of Michigan's largest distributors of power plant equipment, established in 1911, with James E. Walsh manager and owner, have moved to new sales headquarters on the seventh floor of the Fisher Building, Detroit, Mich.



The Crew

Machinery can do many things, but it takes good men to handle it. H. O. Penn Company, distributors of construction equipment, presents "The Works" as lined up in the new warehouse at Port Morris Terminal, New York City.

Why DeLaval
Turbine Driven Pumps
are Replacing
Reciprocating Pumps
They pump water at the lowest possible cost when all items of expense are considered.
The first cost is less — Building and foundation costs are lower — Upkeep and attendance expenses are reduced — High duties are realized.
The photograph shows a De Laval 40 MGD. geared turbine driven centrifugal pump installed alongside a 30 MGD. triple expansion pumping engine in the Milwaukee Water Works, both units pumping against the same head.
De Laval Steam Turbine Co., Trenton, N. J.

CAREY Elastite Expansion Joint never melts in hot weather, nor can it become brittle at zero. As easily handled as a board—saves time—any laborer can install it.

The Philip Carey Company
Lockland, Cincinnati, Ohio

Carey Elastite
EXPANSION JOINT

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Deep-Well Pumps.—The "Moturbo Water Boy" is a deep-well turbine pumping unit, specially designed and built to serve the domestic requirements of farmers and the needs of private estates and small industrial plants. Write to the Peerless Pump Co., 1902 E. Sixty-seventh St., Los Angeles, Calif., for a folder describing this unit. The manufacturers will be pleased to advise you concerning your water requirements.

Centrifugal Pumps.—Fig. 520 Fairbanks-Morse centrifugal pumps are described in Bulletin No. 5015 of Fairbanks, Morse & Co., Chicago, Ill. Tables giving sizes and capacities and dimensions are included. Copies will be supplied upon request.

Spreaders.—Bulletin No. 101 of the Stolle Road Equipment Co., describes the Stolle "Senior" spreader for road material. This spreader may be attached to any dump truck and will operate equally well irrespective of the direction in which the truck travels. The folder contains photographs of the spreader in action and instances of the savings effected through its use. Write to the Stolle Road Equipment Co., Inc., 321 South Grand Blvd., St. Louis, Mo., for a copy.

Knickerbocker Mixers.—Catalog No. 29 presents the complete line of Knickerbocker concrete, mortar, plaster and mastic mixers. A feature of the concrete mixers is the new Knickerbocker device for securing accurate control of the water introduced into the mix. Dimensioned drawings and detailed specifications of the mixers are included. This catalog also describes Knickerbocker saw rigs. Write to the Knickerbocker Co., Jackson, Mich.

High-Early-Strength Cement.—Examples of the saving of time on paving jobs by the use of "Incor" high-early-strength portland cement are cited in a folder recently issued by the International Cement Corp., 342 Madison Ave., New York, N. Y. This corporation is composed of 11 cement companies in the United States, Cuba, and South America, which have a combined output of 20,000,000 barrels of cement annually. Contractors and officials who are interested in minimizing delays caused by construction should write for this bulletin.

Hood Pneumatic Tires.—The Hood Tire Co. has issued two booklets, "A New Leader Among the Giant Pneumatics" and "How to Get More Mileage and Better Service from Pneumatic Truck Tires." As indicated, the former is the story of the Hood truck tire, whilst the latter contains information and suggestions for truck drivers. The manufacturers will be pleased to send you copies.

Marquette Cement.—"Marquette Super Cement Concrete" is the title of a 24-page booklet recently issued by the Marquette Cement Manufacturing Co., Chicago, Ill. Various jobs in which Marquette cement has been used are illustrated. There is included a brief manual of recommended construction practice, covering the structural use of this manufacturer's product. Write for a copy.

Street and Parking Signs.—A folder from the A. D. Joslin Manufacturing Co., Manistee, Mich., describes the Joslin line of weatherproof street signs. Standard street markers and parking and zone signs are illustrated. Joslin street signs are guaranteed to be readable for 10 years. The makers will be glad to provide you with a folder.

Motor Sweepers.—The Austin motor pick-up sweeper is described in Catalog No. 8, issued by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill. This is a sprinkler-sweeper with oscillating gutter broom and rear pick-up broom. The catalog contains specifications and detailed drawings, photographs and cross-sections of the sweeper. The manufacturers will be pleased to furnish you with a copy.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

Street Signals. — Write to the Rochester Street Signal Co., 400 Ward Building, Rochester, N. Y., for a folder describing "Monroe" and "Simplex" street signs. The "Monroe" unit is the only one in the market that employs no screws, nuts or bolts in the assembling. The fittings are made of aluminum. The sign plates are enameled. Inquiries are invited.

Wallace & Tiernan.—We have had the pleasure of receiving the latest Wallace & Tiernan bulletins, by title "Vacuum 'Type MSV' Chlorinator," "The Sanitation of Swimming Pools," "Chlorine in Sewage Purification," "Chlorination of Small Water Supplies" and "Wallace & Tiernan Highway Flashers." The use of chlorine in the disinfection of sewage is increasing, and a perusal of the Wallace & Tiernan bulletin dealing with this application of their products is recommended to all engineers and officials dealing with the and a perusal of the Wallace & Tiernan highway flashers are dry battery operated. The booklet includes specifications, drawings and typical layouts. A traffic engineer in the employ of the company is at the service of all municipalities having traffic problems. The Wallace & Tiernan publications are attractive typographically, delighting the eye at the same time as the mind is instructed by the subject-matter. Wallace & Tiernan Co., Inc., Newark, N. J., will be glad to send you copies.

Toncan Iron.—The use of Toncan iron in perforated, corrugated iron underdrains is described in booklets recently published by the Canton Culvert & Silo Co., Canton, Ohio, and the Toncan Culvert Manufacturers' Association, Massilon, Ohio. Both booklets deal with the general problems of drainage, and contain technical and practical discussions of the design and application of Toncan copper molybdenum iron drains. Toncan iron is manufactured by the Central Alloy Steel Corp., Massilon, Ohio.

Rotary Positive Blowers.—The P. H. & F. M. Roots Co., of Connersville, Ind., has just issued a new 16-page bulletin, No. 22-B1, on low-pressure type rotary positive blowers. The bulletin covers the new Roots modernized blowers, equipped with Timken, SKF or Hyatt bearings. The bulletin includes a dimensioned print, a table of sizes giving speeds, capacities and horsepowers at various pressures and a brief review of various types of pumping units. Bulletin 22-B1 replaces the former bulletin 1011 issued by this company, and is so constructed as to make it a valuable addition to the large Roots catalog covering pumps, meters and blowers. Write to the manufacturers for a copy.

Pioneer Gravel Equipment.—The Pioneer Gravel Equipment Mfg. Co., with offices in Minneapolis, Minn., will be pleased to send you literature and catalog describing the Pioneer gravel equipment line, which features portable screening, crushing and loading plants. The Pioneer line includes eleven sizes of crushing plants and five distinct sizes of gravel loading plants. In addition, the line includes draglines, shaker and revolving screens, belt conveyors,

GOLDEN-ANDERSON

GOLDEN-ANDERSON

Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed-water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressures.

Sizes ½ in. to 24 in.

Automatic "Cushioned" Controlling Altitude Valves

Cushion All Water Surges

Automatically maintain a constant stage of water in reservoirs, tanks and standpipes.

They do away with the annoyances of Freezing Valves or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer. There are no dangerous surges to burst water mains. **Write for details.**

REMEMBER

Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

Golden-Anderson Valve Specialty Co.
1385 Fulton Bldg., Pittsburgh, Pa.

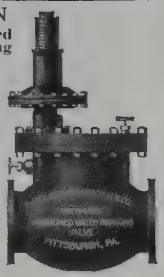
GOLDEN-ANDERSON

Patent Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON

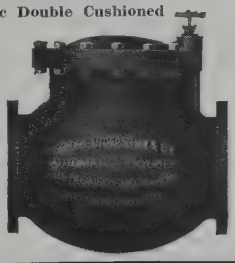
Pat. Automatic Cushioned Water Pressure Regulating Valves



1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON

Pat. Automatic Double Cushioned Check Valves



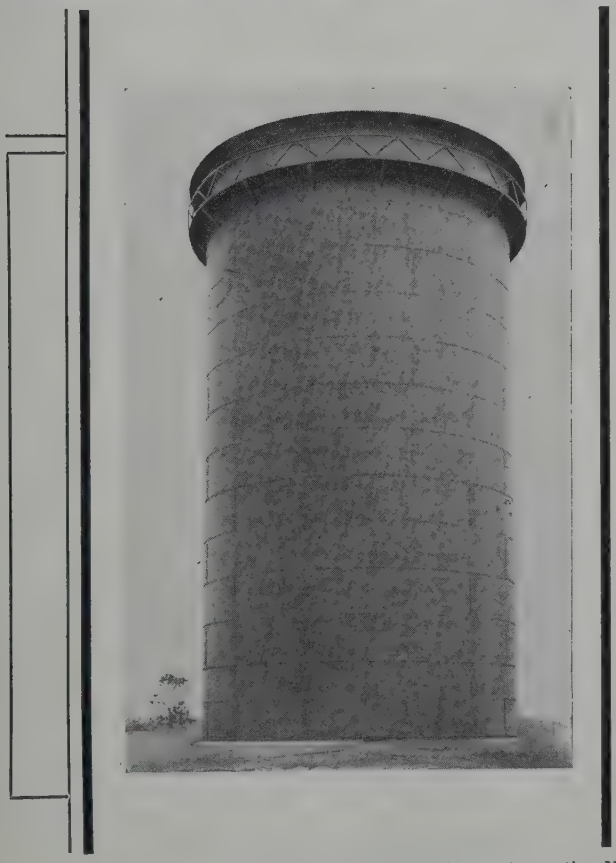
1. Especially adapted for Water-Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering, or Sticking.
4. Globe or Angle Patterns up to 24-in.
5. Especially adapted for hydraulic elevator service.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal-to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.

Sizes ½" to 24".



WATER WORKS ECONOMY

THE Methods of water storage have advanced rapidly, and many American towns and cities enjoy the conveniences and assets of a modern water system.

A gravity water system with a Pittsburgh-Des Moines water tower or standpipe means an efficient, economical plant. A few hours of pumping each day keeps the tank filled and gravity delivers plenty of water wherever and whenever it is needed. Continuous pumping and expensive supervision are eliminated.

We build a complete municipal water works system, including pumping stations and pipe lines. An engineer from our nearest office will gladly write or call to discuss tanks or the general contract for your water works.

Pittsburgh-Des Moines Steel Co.

4 Neville Island, Pittsburgh, Pa.
906 Tuttle St., Des Moines, Ia.

New York Chicago Dallas Atlanta
Seattle San Francisco

in three widths and several sizes of gravel storage bins.

Vertical Gas Engines.—Bulletin 782 of the Chicago Pneumatic Tool Co. describes the type RHG 75 vertical gas engines manufactured by this company. This is really a diesel engine adapted to the use of gas as a fuel. The booklet contains dimensioned drawings and photographs. The manufacturers will be glad to send you a copy. This company maintains an engineering department placed at the service of the customer to assist in solving difficulties and to make recommendations. Service branches are widely distributed and skilled service men are quickly available.

Bilge Pumps.—Bulletin B-3400 of the Yeomans Brothers Co., 1433 Dayton St., Chicago, presents the Yeomans line of heavy-duty bilge pumps. These pumps are built in single and duplex types and can be furnished with regular equipment or with a number of special features such as slow-speed motors, high water alarms, pipe casings for floats, automatic oil economizers, etc., which increase still further the reliability and durability of the machines. Drawings and data tables are included. Write to the manufacturer for a copy.

Servicised Products.—Catalog No. 12 of the Servicised Products Corp. has just come from the printer. This book deals with expansion joints in a rather brief but fairly complete manner, and treats exhaustively of other Servicised products of later development. Most important of these are fibrated asphalt planking, industrial flooring, rail filler, highway crossings and protection course for waterproofing. Readers interested in any way in waterproofing protection materials for use in connection with concrete construction for any purpose will find much that is interesting in the new Servicised catalog. Servicised expansion joints are treated completely in Servicised catalog No. 11, which is also available.

Manganese Steel.—Uses of "Amsco" manganese steel with "Fahralloy" products are described in a folder issued by the American Manganese Steel Co. "Fahralloy" is the name given to a series of alloys, at present fifteen in number, each having nickel and chromium in its analysis. "Fahralloy" products are adapted to uses where resistance to heat and corrosion is important. The American Manganese Steel Co. offers the cooperation of a department, directed by Dr. F. A. Fahrenwald, internationally known metallurgist, for the development of new and special metals to cope with unusual conditions. They will be glad to send you this bulletin upon application to any district sales office.

Water Wheels.—Bulletin W203 of the James Leffel & Co. is the first of a series being prepared on typical Leffel water wheel installations. This bulletin features the open penstock installation with submerged type gate operating mechanism. Inasmuch as the details in most water wheel installations are entirely covered by concrete or water, or both, the illustrations shown in this and succeeding bulletins will be of particular interest to users of water wheels. Write to the James Leffel Co., Springfield, Ohio, for a copy.

Power Graders.—A new folder from the W. A. Riddell Co., Bucyrus, Ohio, describes the Warco model "E" and "ER" power graders. Detail photographs and specifications are presented. The manufacturers will be pleased to send you a copy.

Meter Boxes, Valve Housings, Etc.—A new ten page folder has just been received from H. W. Clark Company, Mattoon, Ill., illustrating and describing their gray iron products. The meter boxes are equipped with Wonder Lock, the key serving as handle of box, which cannot be removed without locking box. Products shown are: Meter boxes, box covers, wonder lock, valve boxes, valve housings, extension rings, repair lids, service box wrenches, etc. Illustrations clearly bring out the advantages of these products.

Airports.—"Getting on the Air Map with Caterpillar" is the title of a very attractive booklet issued by the Caterpillar Tractor Company, San Leandro, Cal. Booklet states: "There are more than 1,000 airports in the U. S.—some still in the making. The country needs 10,000." Booklet gives much interesting information concerning what is being done in various parts of the country to meet this need. Send for a copy, kindly mentioning our magazine.

Foundries.—Three folders, of special interest to foundry men, have just been issued by the Link-Belt Company, 910 S. Michigan Avenue, Chicago. These booklets describe the Continuous Malleable Foundry of the Saginaw Malleable Iron Division of General Motors Corporation; the three foundries of the American Manganese Steel Company, and the Link-Belt Vibrating Screen. The Link-Belt Company will be pleased to send copies upon request. If writing kindly mention our magazine.

Sluice Gates.—W. C. A. No. 32 issued by Rodney Hunt Machine Company, 101 Lake Street, Orange, Mass., gives some valuable information on sluice gates and hoisting equipment. This company, manufacturers of water controlling apparatus, will be pleased to give you detailed information about their hand operated, motor operated and hydraulic cylinder operated hoists and stands and accessories for all types of sluice gates, wide bronze facings, eliminating corrosion.

Concrete Pipe.—A very attractive book, giving much useful information on the sanitary engineering field as it applies to concrete pipe, is that issued by the Independent Concrete Pipe Company of Indianapolis, Ind. It is printed on heavy enamel paper, with many clear and comprehensive illustrations and is stitched into a heavy cardboard cover of pleasing appearance, putting the information into permanent form. In addition to a short history of the field, it gives the design, specifications and manufacturing methods of Independent Reinforced Concrete Pipe. The illustrations show manufacture and installations in places described.

Reinforced Concrete Pipe.—A pamphlet issued by the Lock Joint Pipe Company of Ampere, N. J., gives complete description and illustrations of reinforced concrete pressure pipe, which is of three kinds, poured pipe, cylinder pipe and centrifugal pipe and with expansion joints of two types, "Lead and Iron Joint" and "Lead and Steel Joint." All forms are steel held by cast-iron rings, insuring great accuracy and especial smoothness. In addition to photographic illustrations booklet contains several blue print drawings. Copies may be secured from eastern office, or from Chicago branch at 110 S. Dearborn Street.

Wrought Iron.—The A. M. Byers Company, Pittsburgh, Pa., has issued in handsome pamphlet form a reprint from World's Work "The New Story of Ancient Wrought Iron," by Donald Wilhelm. This is a story of the making of wrought iron from the earliest record down to the Aston Process put into practice last year by the A. M. Byers Company at their plant near Warren, O., and for which a new plant is being constructed at Ambridge, Pa. The manufacturer will no doubt be pleased to send copy of this reprint to anyone interested.

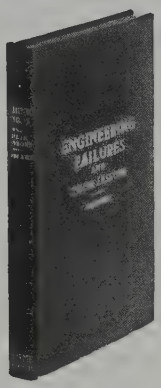
Street Department Supplies.—Catalog No. 31 issued by the Safety Gas Main Stopper Company, 523 Atlantic Avenue, Brooklyn, N. Y., bound in loose leaf type, illustrates and describes a long list of products including gas main bags, main plugs, stoppers, gauges, pipe cleaning brushes, cylindrical stoppers for water mains, etc. The new gauge and gas bag valve combination eliminates guess work in the use of inflatable bags and stoppers on which a pump is used. The pressure gauge shows when the pressure is sufficient and whether the bag is holding or losing air.

Mixer.—Koehring Company, Milwaukee, Wis., will be pleased to send you a special circular on the Koehring Weigh Mix, a standard heavy duty mixer with weighing batch hopper and water tank mounted on an auxiliary frame. All operations are controlled from platform, all aggregate is weighed in one hopper and water weighed on same beam.

Deep Well Power Plant.—The United Iron Works, Inc., Tulsa, Okla., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems.

Water Meters.—For literature on water meter setting and testing equip-

Only Experienced Men Wanted



to Read Godfrey's

Engineering Failures

When you know the construction game you'll appreciate the stimulation of this challenging book. Mr. Godfrey, from his wide engineering experience startled the technical world by digging into a delicate subject,—the whys and wherefores of failures,—falling bridges, breaking dams, collapsing buildings,—most of them front page newspaper stories the day after the catastrophe.

Whether you agree with the conclusions, or not, you cannot fail to know your job better when you have analyzed the facts in these cases with Mr. Godfrey. Read the book during a 10 day trial period before you decide whether you will buy it.

Gillette Publishing Company
221 E. 20th St., Chicago, Ill.

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Please send me postpaid for free examination Godfrey's "Engineering Failures." In 10 days I agree to return the book or remit $3 in full payment and keep the book for my further profitable use.

Name.....

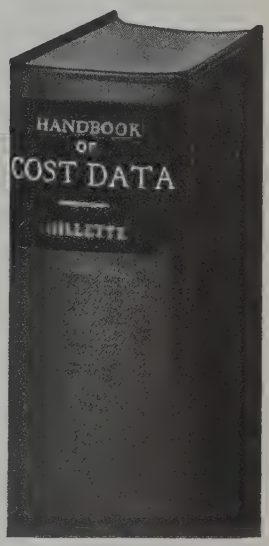
Company.....

Address.....

City and State..... WW-7-29

WHAT IS A HANDBOOK?

This one is HANDY PRACTICAL HELPFUL and



Worth Its Weight in Gold When Kept at Hand

for Constant Reference

A handy book from which you can take profit each time you consult it,—that describes H. P. Gillette's "Handbook of Cost Data." If in its 1854 pages there is not more value to you than its price, you do not need it. But we believe you will find it worth many times its cost. Thus, we offer to send it for your examination, so that you may either buy or return it. Read our offer in the coupon below, then fill in and mail it.

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Principles of Engineering Economics and Cost Keeping—Earth Excavation—Rock Excavation, Quarrying and Crushing—Roads, Pavements and Walks—Stone Masonry—Concrete and Reinforced Concrete Construction—Water Works—Sewers—Timber Work—Buildings—Railways—Bridges and Culverts—Steel and Iron Construction—Engineering and Surveys—Miscellaneous Cost Data.

H. P. Gillette's

Handbook of COST DATA

Gillette Publishing Company
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Please send me postpaid for free examination the "Handbook of Cost Data." In 10 days I agree to return the book or remit $6 in full payment and keep the book for my further profitable use.

Name.....

Company.....

Address.....

City and State..... WW-7-29

ment write to the Ford Meter Box Company, Wabash, Ind. Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently.

Sewer Cleaning Machine and Rods.—W. H. Stewart, P. O. Box 581, Jacksonville, Fla., and branches in St. Louis and Boston, as well as factory in Walkerville, Ontario, will be pleased to send literature describing his sewer cleaning machine and conduit rods. Folder describes the hand power machine or the Wonder Bucket equipment. Sewer rods are also illustrated and described, and a list of hand tools for use with sewer rods. This sewer cleaning device will remove anything possible to get into a sewer and clean thoroughly with the least possible difficulty.

Zeolite.—The Zeolite Chemical Company, 140 Cedar Street, New York City, will be pleased to send you "Softening Municipal Water Supplies by the Use of Zeolite," a booklet which describes green sand, a natural base exchange Zeolite mineral, used for water softening. Much interesting information is given.

Stillson Wrenches.—Sando Original and Moroco Popular Stillson wrenches, formerly made by the Moore Drop Forging Co. of Springfield, Mass., are now manufactured by the Trimont Manufacturing Company, 55 Amory Street, Roxbury, Boston, Mass. The Sando has a drop forged handle and jaw, and is scientifically hardened for maximum strength. Handle is made in wood or steel type. Both Sando and Moroco are described and sizes and prices given in booklet which will be sent by manufacturer upon request.

Fire Hydrants and Valves.—The Mathews Fire Hydrants built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia, Pa. A broken Mathews can be replaced is a very few minutes and without excavation or breaking up the pavement. Manufacturer will be pleased to send you full information.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., have had reprints made of a paper by Harry F. Ferguson (chief sanitary engineer, division of sanitary engineering, department of public health, Springfield, Ill.), and Clarence W. Klassen (assistant sanitary engineer, division of sanitary engineering, department of public health, Springfield), and appearing in the January issue of the Journal of the American Water Works Association. The title of the paper is "Are Your Wells and Reservoirs Contaminated?" The report treats of sources and reasons for water contamination, and states: "If owners of public water supplies overlook * * * or permit * * * contamination to continue * * * such owners * * * would be liable for damages for any illness * * * in accordance with recent court decisions." Wallace & Tiernan Co., Inc., will be pleased to send you a copy of this reprint, together with their technical bulletins describing their Chlorinators. Chlorination in the instances cited in the report would have protected the public health. Write for this literature.

Traffic Signals.—Catalog No. 129 has been issued by the Interflash Signal Corporation, 120 Broadway, New York City, describing Interflash "U. S. Standard" road signs and beacon signals for day and night service. Catalog describes the various types illustrated for use on highway and at street intersections where only a warning or cautionary signal is required. These are operated by either self-contained acetylene gas flushing equipment or direct from electric power lines. If interested in all-electric type of control signals ask for Catalog No. 229. For navigation lights for lighthouses, towers, buoys, wharves, bridges, etc., write for Catalog No. 329.

Chemicals.—The Kalbfleisch Corporation, 200 5th Avenue, New York, will be pleased to send you booklet on this subject in its connection with industries. The booklet is very handsome appearing, containing 84 pages, the first part being devoted to the sources, manufacture and uses of chemicals, together with a long list manufactured by the company—industrial and miscellaneous chemicals. The tables at the back of the book give atomic weights, corrections for temperatures and many other tables to serve the chemical user.

Hot Process Water Softener.—A new 12 page catalog in loose leaf style, Bulletin No. 5049, has just been issued by the Graver Corporation, East Chicago, Ind., describing their hot process water softener. Catalog gives views of installations and the component part of the softener. Booklet also contains tables showing savings made by use of softener. An extension to the front cover printed in colors enables the reader to refer to it as he reads the text of the booklet. An informative and attractive bulletin.

Paint Spray Brush.—Simons Paint Spray Brush Co. of Dayton, O., have issued a little booklet describing their paint spray brush and electric and gasoline air compressors to use with it. Containers, fittings, etc., are described and illustrations show the brush at work. For difficult painting jobs, such as large steel water towers, highway bridges, etc., this equipment saves in labor and paint. Ask for a copy of booklet G.

Tractors.—Catalog B-100 issued by Foote Bros. Gear & Machine Co., 215 N. Curtis Street, Chicago, covers all three models of the Bates "Steel Mule" tractor, 30-40-80. The Bates "Steel Mule" is easy to handle, has few wearing parts, and powered by Waukesha motor, it operates at high efficiency at all operating speeds. The crawlers run full length of tractor so it cannot nose into a bank with its radiator. Equipped throughout with IXL-ITE tool hard gears. Booklet fully illustrates, describes and gives specifications of all models.

Fire Hydrants, Gate Valves, Boxes, Indicator Posts, Etc.—A very attractive folder has been issued by the Iowa Valve Company, 701 Hubbell Building, Des Moines, Ia., giving the latest improvements on the products of this company, whose factory is located at Oskaloosa, Ia. Particular attention is called to the many improvements in the fire hydrant, such as the positive mechanical drip valve, bronze working parts, rubber mounted valve, new and improved adjusting feature which insures main valve in line with seat, all working parts removable through top of standpipe without use of special wrench or tripod, unrestricted water flow, delivering full pressure and simple construction. Folder gives description and illustration of fire hydrant and many of the other products of the company.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., manufacturers of chlorine control apparatus, will be pleased to send you full information concerning their MSP Chlorinator. This equipment in duplicate is protecting hundreds of small cities by safeguarding their water supply. Records of cities where this method is in use will be furnished as well as much interesting information concerning sterilization of water.

Centrifugal Pumps.—Booklet W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., contains much interesting information concerning their geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. Pumps for general water service, power plant service, sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. Write for literature.

Planning a Waterworks System.—This is the title of a little booklet which the Cast Iron Research Association, Peoples Gas Building, Chicago, will be pleased to send you upon request. No community of 500 persons can afford to continue without a waterworks system, and many smaller towns have excellent systems. Booklet discusses Engaging the Engineer; Plans; Source of Supply; Estimating Requirements; Pumping System; Duplicate Equipment; Storage Supply; Distribution; Pipe; Hydrants; Records; etc.

Sewage Treatment Plants.—Bulletin No. 101, dated February, 1929, has just been received from the Pacific Flush Tank Company, 4241 Ravenswood Avenue, Chicago, or 9 Park Place, New York, describing the Sprinkling Filter Design using the Twin Dosing Tank Equipment. It is a very comprehensive

New Low Price Miami Backfiller for the Fordson $90

The new low price on the Miami Fordson Backfiller includes Power Winch, Extension for rear of Tractor, sufficient cable for all kinds of work, and Mormon Board. No better value was ever offered for the filling of trenches and small grading operations.

If you own a Fordson, the Miami Backfiller unit will save you hundreds of dollars. Works either side or back of tractor. Does not interfere in any way with using the tractor for other purposes. The power through the Miami Winch is double the drawbar power of the tractor. Can be used in unusual positions and tight places, as tractor remains stationary, all motion is through the winch and backfiller board.

No matter how small your backfilling, trench filling or grading jobs may be the Miami Backfiller will earn money for you. Write today for complete details.

The Miami Trailer-Scraper Co., Troy, Ohio

For Municipal

WATER SOFTENING

Specify

NATURAL-ZEO-MINERAL

A GREEN SAND ZEOLITE

Send for interesting bulletin M "Softening Municipal Water Supplies by Use of Zeolite."

Sold With a Guarantee

And Produced By America's

Pioneer Producers

ZEOLITE CHEMICAL CO.

140 Cedar Street **New York**

POROUS CONCRETE

LARGE CAPACITY WELL

Guaranteed not to pump sand regardless of its fineness with no restriction to capacity

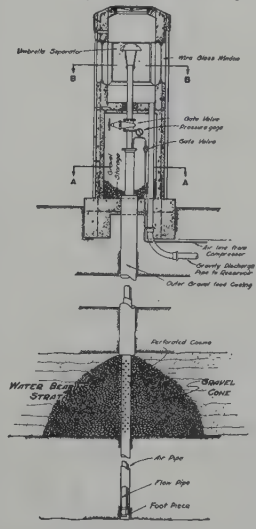
Made, Installed and Guaranteed

F. THORPE

1932 Illinois Avenue **East St. Louis, Ill.**

Can the Gallons-per-Minute be Maintained?

Scores of cities now say "Yes, with Sullivan Air Lift"



When your wells slow up—there is usually plenty of water available. But sand has packed around the screen and reduced the inflow—or it has worn the mechanical pumps so they do not carry a full load of water. Both of these difficulties are overcome by the Sullivan Air Lift System and "Air Made" Wells. Sand is removed from the well and replaced by coarse gravel. And there are no moving parts in the well to be damaged by sand. Scores of these wells have been installed where other wells went dry. And in every instance the Sullivan Well maintained or increased its production.

At Tonkawa, Oklahoma, ten of these wells doubled in flow in two years, while other wells all around them were abandoned. At Chandler Oklahoma, one "Air Made" Well produced more water than forty mechanical wells previously used. And in many other places Sullivan Air Lift has solved the problem of wells slowing up.

Sullivan Air Lift will give you "dependable water supply anywhere". Why not send for Catalogs 71-I, and 56-J?

Sullivan Machinery Company

418 N. Michigan Ave., Chicago

presentation of this type of sewage treatment, and contains many detailed illustrations and data concerning large plants in use throughout the country. There are several pages of design data for single and twin tanks with percentage tables. There are also cuts and descriptions of dosing tank counter, nozzles and Marley Tees.

Chlorinizer.—Bulletin No. 20 put out by the Paradon Manufacturing Co., Arlington, N. J., gives full description of Paradon Chlorinizer. Chlorinization is in universal use for sterilization of water supplies, sanitation of swimming pools and for the disinfection of sewage. Operation, advantages, capacity, types of chlorinizers, applicability and specifications are all given in bulletin, and a list of a few typical installations is also included, regarding the Paradon equipment, a chlorinating device for small water supplies, swimming pools, and sewage plants such as in use in small municipalities, factories, camps, estates, country clubs, hotels, etc.

Cast Iron Pipe.—Write to the Central Foundry Company, 420 Lexington Avenue, New York City, for information concerning the cast iron pipe with machined hub and spigot ends, all cast iron, eliminating calking or use of any jointing material. No tool needed but a wrench.

Manhole and Catchbasin Covers.—Wm. E. Dee & Company, 30 North La Salle Street, Chicago, will be pleased to send prices and full particulars concerning their D & D Safety Cover. They guarantee this cover not to rattle or dish.

Diesel Engines.—A bulletin from the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., has been issued describing the diesel power plant at Freeport, L. I., N. Y., where the 6th Busch-Sulzer Diesel—a 1,500 B. hp.—1,050 kw. unit, has just been purchased, making this the largest municipal Diesel plant in the United States, according to statement contained in folder. Their Diesel engines are built in 2-cycle and 4-cycle types, stationary and marine.

Steel Storage Tanks.—Municipal Catalog No. 2 issued by the Pittsburgh-Des Moines Steel Company, 4 Neville Island, Pittsburgh, Pa., give description and information regarding the product of this company for taking care of water consumption during the peak hours and insures a constant pressure at all times. Use of these tanks eliminate fire hazards when repairs are being made at the pumping plant. Information will be furnished concerning complete water works system, pipe lines, reservoirs, filtration, purification, etc.

Fact Book of Steel Construction.—The American Institute of Steel Construction, Inc., 285 Madison Avenue, New York City, has just published a Fact Book which lists the steel fabricators of the United States, Canada, Mexico and Hawaii. It presents in chart and tables the statistics of steel, fabrication and construction work. In addition to presenting data relating to the tallest and largest buildings in the United States it also publishes for the first time the most complete list of steel bridges in the U. S. This book has been brought out because of the now general use of the skyscraper throughout the land and the widespread interest in the fabrication of structural steel.

Porous Concrete Well.—F. Thorpe, 1932 Illinois Avenue, East St. Louis, Ill., will be pleased to send you folder describing this type of well and will furnish a list of references. Some of the outstanding features are length of life, elimination of repair or maintenance costs, satisfied owners, etc.

Toledo Torch.—The new Toledo Torch "Champion" is the product of the Toledo Pressed Steel Co., Toledo, O. Write to the manufacturer for full information as to construction, service and costs.

Steel Sheet Piling.—Address Wemlinger, Inc., Singer Building, New York, or 228 North La Salle Street, Chicago, for information in regard to buying or renting steel sheet piling.

Clay Products.—Wm. E. Dee Clay Mfg. Co., 30 N. La Salle Street, Chicago, manufacturers of standard and double strength sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick, will be pleased to send you full information on any or all of these products.

Sewer Flusher.—Petersen's Hydraulic Flusher Company, 277 First Avenue, Milwaukee, Wis., will be pleased to send you literature illustrating and fully describing their sewer and pipe flushers. It is made in three styles of heavy grade canvas and waterproof tubing. A labor saving tool for city, contractors and manufacturers, and an economical way of clearing sewers.

Cast Iron Pipe.—An attractive folder from the McWane Cast Iron Pipe Company of Birmingham, Ala., and Provo, Utah, shows many successful uses for this pipe. It is used in parks for feeding sprinkling systems, by railroads in yards for water, air and low-pressure steam lines, etc., all of the 2-in. size. It is also made in 4, 6, 8, 10 and 12-in. sizes. Manufacturer will be pleased to send literature illustrating and describing pipe in all sizes for all uses.

Pumps.—Bulletin P-29 issued by the Jaeger Machine Company, Columbus, O., gives illustrations, specifications and full description of diaphragm, plunger type, lift and force centrifugals. The Speed Boy is a 4-cycle high speed engine with foot starter coupled with non-clogging big volume pump with Jaeger open type brass impeller that handles 25 per cent to 28 per cent solid matter such as sand, mud or solid stones. Write for this bulletin.

Cast Iron Pipe.—A very attractive booklet called "Small Diameter Cast Iron Pipe" has just been issued bearing the name of the American Cast Iron Pipe Co., Birmingham, Ala. Types of small diameter pipe described in booklet include: Simplex Prepared Joint Cast Iron Pipe; Two-Inch Bell-and-Spigot Cast Iron Pipe; Two-Inch Prepared Joint Cast Iron Pipe; Threaded-End Cast Iron Pipe; Doublex Simplex Cast Iron Pipe; Flanged Cast Iron Pipe; Cast Iron Pipe for Vitaulic Joints; Bronze Welded Joints and Small Diameter Cement Lined Pipe. Booklet is printed on heavy enamel paper and has an extra heavy cover.

Calatom.—An admixture for concrete which is mined, milled and refined exclusively by Monterey Products Company, Monterey, Cal., and distributed east of the Rocky Mountains by Tamms Silica Company. Calatom is a low water absorption diatomaceous earth for workability and waterproof concrete. Write to the Tamms Silica Company, Stock Exchange Building, Chicago, Ill., for literature giving complete information concerning this powered admixture.

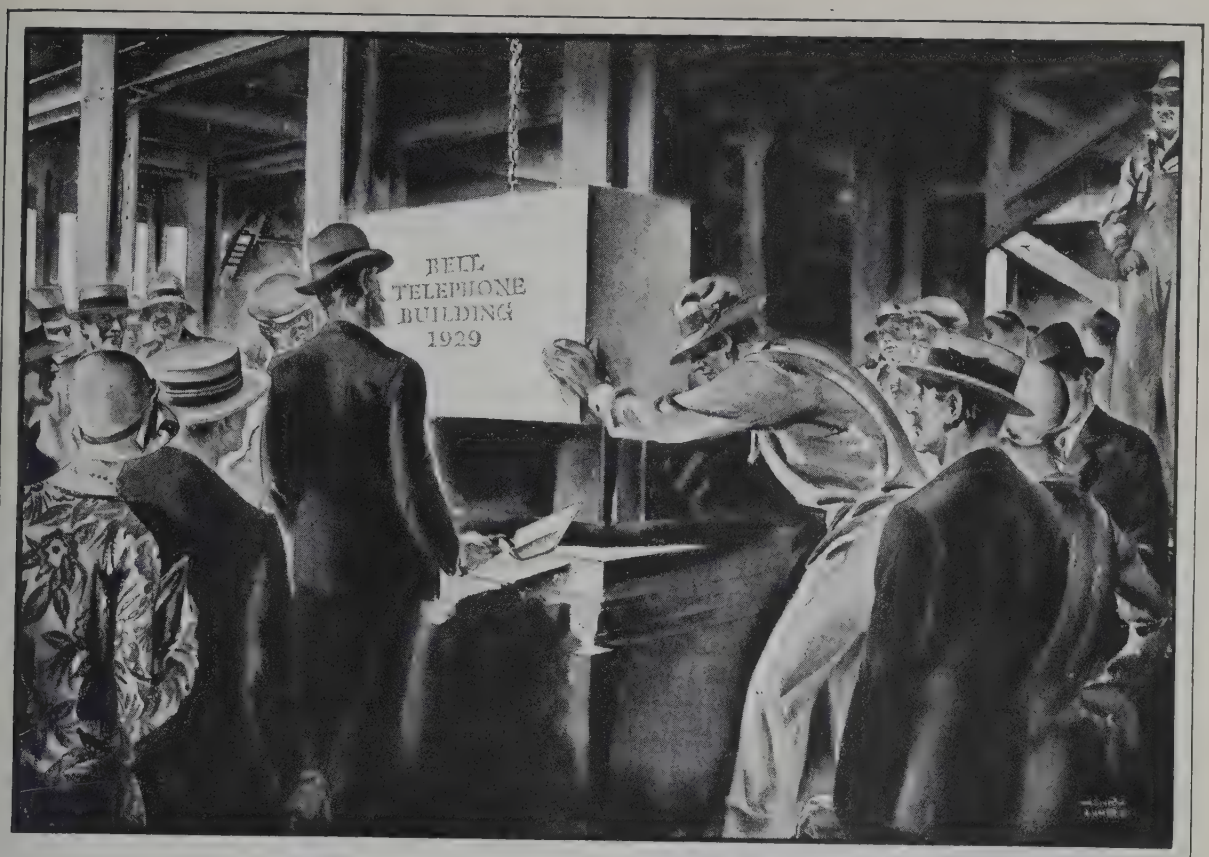
Deep Well Water Systems, Etc.—Alamo Engine Company, Hillsdale, Mich., has issued a very attractive 60 page booklet in loose leaf style, describing the use of Alamo-Dorward Rotary Power Head, for operating deep well and other types of reciprocating plunger pumps. Booklet contains cross sectional drawings, explanation of capacity table captions with several pages of capacity tables.

Meter Boxes, Couplings, Testers, Service Boxes, Etc.—Catalog No. 24 issued by H. W. Clark Company, Mattoon, Ill., gives full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for accessibility for repair work or replacements. Full particulars furnished on all equipment.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Cast Iron Pipe.—"Spi-Cor" is the title of a little booklet issued by the American Casting Company, Birmingham, telling the story of a new era in "culverting." It gives much interesting information in condensed form on spiral corrugated cast iron pipe. If writing for booklet, kindly give the name of our publication.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Municipal News and Water Works, 221 E. 20th St., Chicago.



THE BELL SYSTEM IS BUILDING AHEAD OF THE GROWTH OF THE COUNTRY

This is the telephone's job and goal

An Advertisement of the
American Telephone and Telegraph Company

THE United States is developing a new civilization. The telephone is an indispensable element in it. The Bell System is building ahead of the growth of this civilization. In 1929 the telephone budget for land and buildings is 54 million dollars, with new buildings rising in 200 cities. New equipment for central offices will cost 142 millions; exchange lines 120 millions; toll lines 119 millions.

The Bell System's total expenditure for plant and service improvements this year will be 559 million dollars.

This outlay is required because the telephone is a universal servant of this democracy. Business uses it to create more prosperity. Homes use it for comfort and protection, for keeping friendships alive and enriching life. Its general use enables each personality to extend itself without regard to distance.

The telephone ideal is that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

R. Emerson Swart, at 28, Elected to Head Large Public Utilities Organization

The Community Water Service Company, one of the largest holding corporations in the United States operating water utilities, announces the recent election of Mr. R. Emerson Swart as

R. Emerson Swart, recently elected president of Community Water Service Company

president. This honor places Mr. Swart in the ranks of the leading public utility executives at the age of 28 years. He has been associated with P. W. Chapman & Co., Inc., since 1922, being elected a vice-president of the firm in 1925. In assuming the office of presidency of the Community Water Service Company he succeeds Mr. Chapman, who, according to announcement, is to become chairman of the board of directors.

"Supporting Sales by Service"

Wallace & Tiernan, manufacturers of chlorinators, located in Newark, N. J., many times has been called upon to furnish emergency service in protecting the public health through chlorination of public water supplies. In announcing to water works and public health officials the re-organization of its field forces for more effective sales and service, citation is made of many instances where the staff of this company answered emergency calls.

Notification of the new division and district headquarters of this company in the United States, Canada and Mexico, has been brought to the attention of officials in the field by means of a charted map of North America. This plainly indicates the many conveniently located centers for securing immediate service, and bears the caption "Servicing a Continent."

In the announcement made by Wallace & Tiernan of "Supporting Sales by Service," they point to the specific work done at the time of the St. Francis Dam disaster in California, the Porto Rican hurricane, the floods in the Illinois Valley, western New England and Mississippi Valley and in Alabama, eastern Georgia and Tennessee. Their staff was also found at work in supplying safe water to the British and American expeditionary forces during the World War, aiding hurricane stricken Florida and central Illinois at the time of the tornado.

Air transport now furnishes a new and quicker means of rendering service, and with their headquarters located but 30 minutes distant from the famous Newark Airport, should an emergency arise, their officials announce their ability to ship portable chlorinators by airplane to any part of the United States. Their recent campaign for more effectively covering the field is well named, "Supporting Sales by Service."

Manitowoc Engineering Works, Manitowoc, Wis., will be represented in Philadelphia, Washington, D. C., and Maryland by Mr. H. W. Green, 505 Fox building, Philadelphia, Pa. Mr. Green has taken on the promotion and sale of Moore Speedcranes, shovels, draglines and trenchoes, and the Buffalo-Manitowoc clamshell buckets.

Ohio and Kansas to Have New Prest-O-Lite Plant

Two new plants to supply local industry with dissolved acetylene for oxy-acetylene welding and cutting have been established by the Prest-O-Lite Company, Inc. One plant is located at 540 E. 17th St., Wichita, Kan., and the other at Jones St., and Pennsylvania R. R., Youngstown, O.

The superintendent of the Wichita plant, which commenced operations the latter part of June, is Mr. H. Wilson. The district superintendent for this locality is Mr. W. Webert, with headquarters at the North Kansas City plant.

The Youngstown plant was opened the first part of July, with Mr. A. C. Mattison in charge as superinendent. The district superintendent, whose headquarters are at the Pittsburgh plant, is Mr. C. G. Holt.

Distributor Note

Mr. Fairman B. Lee, sales engineer for the Asbestos Covering & Supply Company of Seattle, Tacoma and Portland, has been east on a trip, calling on several of the large manufacturers represented by his company in the far west. The National Aluminate Corporation and the International Filter Company of Chicago were among the plants visited by Mr. Lee. Mr. Lee's company handles power plant equipment for the A. W. Cash Company of Decatur, Ill.

Foote Perfex Factory Manager

Mr. G. W. Foote has been appointed factory manager of the Perfex Corporation, makers of heavy duty industrial engine cooling radiators according to an announcement made by Mr. D. T. MacLeod, president of the company.

Mr. Foote comes to Perfex from the Republic Metalware Company, Buffalo, N. Y., where for many years he has been general superintendent in charge of production, tools and maintenance. During the war Mr. Foote was connected with the Watertown Arsenal. He also was formerly connected with Geuder, Paeschke & Frey, Milwaukee, Locomobile Company of America and Lake Torpedo Boat Company of Bridgeport, Conn.

C. R. Messinger Elected Director of Gas Light Company

C. R. Messinger, president of the Chain Belt Company, Milwaukee, was elected a director of the Milwaukee Gas Light Company, part of the American Light & Traction Company of New York. Mr. Messinger is also a director of the Sivyer Steel Castings Company, Federal Malleable Company and Interstate Drop Forge Company of Milwaukee, which are affiliated with the Chain Belt Company. He is also a director of the Nugent Steel Castings Company of Chicago. The Chain Belt Company operates a plant in Cleveland, O., under the name of the Stearns Conveyor Company.

Chicago Pump Company of Chicago announces Portland, Ore., territory is now under the supervision of D. R. Munro, 201 Lumberman's Building, Portland.

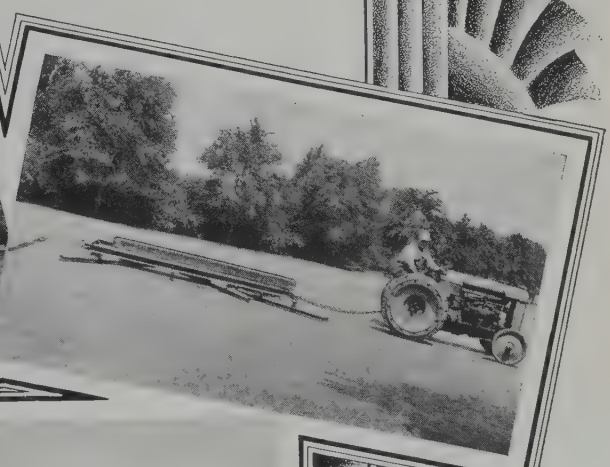
Traffic Conditions Demanded the Best, So They Used Stanolind Cut-Back Asphalt

LAKE SHORE DRIVE through Jackson Park is one of the heaviest traveled boulevards in Chicago.

Recently a ½-inch resurfacing was accomplished, using two applications of Stanolind Cut-Back Asphalt and approximately fifty pounds of aggregate per square yard. The result is a smooth attractive roadway, durable and easy to ride on.

This method of resurfacing is economical and expedient.

First Application of Stanolind Cut-Back Asphalt on the roadway



Mixing stone and cut-back asphalt with multiple blade drag, which develops a uniform smooth riding surface

Completed Roadway

STANDARD OIL COMPANY (*Indiana*)

General Offices: 910 South Michigan Avenue CHICAGO, ILLINOIS

ILLINOIS	INDIANA	IOWA	MICHIGAN	WISCONSIN	MINNESOTA	MISSOURI
Chicago	Evansville	Davenport	Detroit	La Crosse	Duluth	Kansas City
Decatur	Indianapolis	Des Moines	Grand Rapids	Milwaukee	Mankato	St. Joseph
Joliet	South Bend	Mason City	Saginaw	Green Bay	Minneapolis	St. Louis
Peoria	KANSAS	Sioux City	S. DAKOTA		N. DAKOTA	
Quincy	Wichita		Huron		Fargo	Minot

220

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for Northern California territory. Now stocking equipment for several well known machinery manufacturers.

Man experienced in selling road building machinery state highway departments, contractors, county and city officials, would like to make connection as district representative or branch manager. Located in Ohio, but would consider other territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Civil engineer located in Porto Rico would like to hear from manufacturers desiring sole representation for their products in Porto Rico, Santo Domingo and Venezuela. Machinery for highway construction, purification plants, steel for buildings or bridges or other building materials and contractors' equipment.

Sales representative desires business connection with manufacturer of snow plows and road machinery for Minnesota and Northwest territory.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

Manufacturer of water works brass goods, would like to make proposition to manufacturers' representatives calling on waterworks trade.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the Southwest and Middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

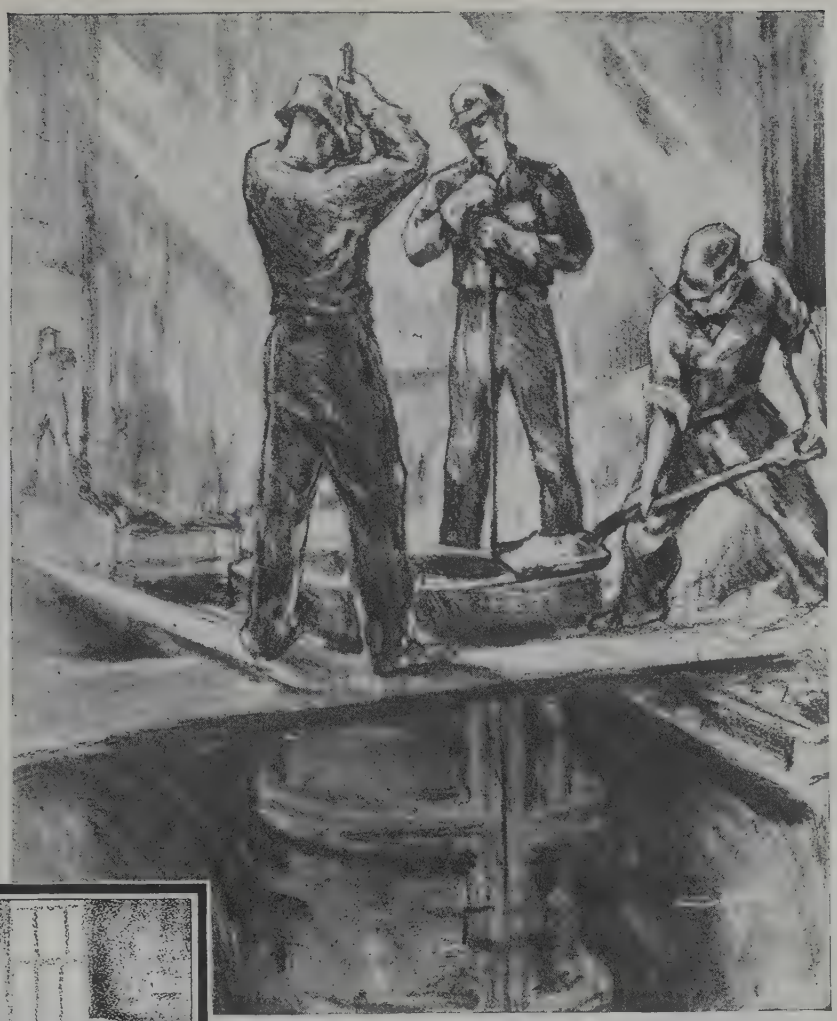
Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

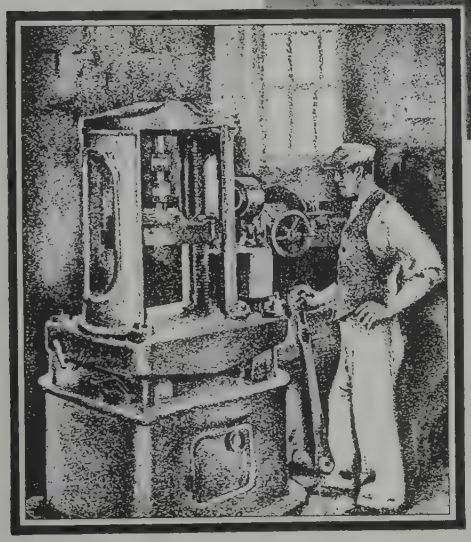
Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Manufacturer of complete line of Construction Equipment, mixers, saw rigs, plaster and mortar mixers and pumps, has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of rotary pump, especially designed for road construction work, has proposition for reliable distribution houses.



The illustration below shows the testing of a section of cast iron pipe for tensile strength. The metal in modern cast iron pipe must show a tensile strength of 20,000 lbs. per square inch.



CAST Q IRON

The "Q-check" symbol shown above has been adopted as the trade mark of The Cast Iron Pipe Research Association. Insist on this "Q-check" mark when specifying cast iron pipe for gas, water, sewer or industrial service. For complete information write to The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, Peoples Gas Building, Chicago.

ONE of the important industrial achievements of the past two decades has been the progress of the cast iron pressure pipe industry. Today, uncertain "rules of thumb" have been superseded by laws of metallurgical science. Today, the age-defying quality and uniformity of every length of cast iron pipe is tested and checked with scientific certainty. Small wonder that modern cast iron pipe is recognized as longest-lived and most economical for water and gas mains.

* * *

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and proper use of Cast Iron Pipe. Pipe bearing the Association "Q-check" mark may be obtained from the following: American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

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CAST IRON PIPE

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Sewage Chlorination.—Wallace & Tiernan Co., Inc., Newark, N. J., has just mailed to all sanitary engineers, sewage plant operators and public health officials in the United States and Canada, a reprint of the article "Advancements and Developments in Sewage Chlorination" by Linn H. Enslow, research engineer of the Chlorine Institute. The article is published in the standard 6x9-in. size used by Wallace & Tiernan for this type of educational publicity. It should be of value to all who are interested in sewage chlorination.

Trailers.—Highway Trailer Co. has recently issued a pamphlet illustrating the many ways in which their trailers serve the public utilities. Contractors in any field will receive many profitable suggestions from this release, which the manufacturers will be pleased to supply.

Deep-Well Pumps.—The "Moturbo Water Boy" is a deep-well turbine pumping unit, specially designed and built to serve the domestic requirements of farmers and the needs of private estates and small industrial plants. Write to the Peerless Pump Co., 1902 E. Sixty-seventh St., Los Angeles, Calif., for a folder describing this unit. The manufacturers will be pleased to advise you concerning your water requirements.

Spreaders.—Bulletin No. 101 of the Stolle Road Equipment Co., describes the Stolle "Senior" spreader for road material. This spreader may be attached to any dump truck and will operate equally well irrespective of the direction in which the truck travels. The folder contains photographs of the spreader in action and instances of the savings effected through its use. Write to the Stolle Road Equipment Co., Inc., 321 South Grand Blvd., St. Louis, Mo., for a copy.

Knickerbocker Mixers.—Catalog No. 29 presents the complete line of Knickerbocker concrete, mortar, plaster and mastic mixers. A feature of the concrete mixers is the new Knickerbocker device for securing accurate control of the water introduced into the mix. Dimensioned drawings and detailed specifications of the mixers are included. This catalog also describes Knickerbocker saw rigs. Write to the Knickerbocker Co., Jackson, Mich.

High-Early-Strength Cement. — Examples of the saving of time on paving jobs by the use of "Incor" high-early-strength portland cement are cited in a folder recently issued by the International Cement Corp., 342 Madison Ave., New York, N. Y. This corporation is composed of 11 cement companies in the United States, Cuba, and South America, which have a combined output of 20,000,000 barrels of cement annually. Contractors and officials who are interested in minimizing delays caused by construction should write for this bulletin.

Marquette Cement.—"Marquette Super Cement Concrete" is the title of a 24-page booklet recently issued by the Marquette Cement Manufacturing Co., Chicago, Ill. Various jobs in which Marquette cement has been used are illustrated. There is included a brief manual of recommended construction practice, covering the structural use of this manufacturer's product. Write for a copy.

Street and Parking Signs.—A folder from the A. D. Joslin Manufacturing Co., Manistee, Mich., describes the Joslin line of weatherproof street signs. Standard street markers and parking and zone signs are illustrated. Joslin street signs are guaranteed to be readable for 10 years. The makers will be glad to provide you with a folder.

Motor Sweepers.—The Austin motor pick-up sweeper is described in Catalog No. 8, issued by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill. This is a sprinkler-sweeper with oscillating gutter broom and rear pick-up broom. The catalog contains specifications and detailed drawings, photographs and cross-sections of the sweeper. The manufacturers will be pleased to furnish you with a copy.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

Street Signals. — Write to the Rochester Street Signal Co., 400 Ward Building, Rochester, N. Y., for a folder describing "Monroe" and "Simplex" street signs. The "Monroe" unit is the only one in the market that employs no screws, nuts or bolts in the assembling. The fittings are made of aluminum. The sign plates are enameled. Inquiries are invited.

Wallace & Tiernan.—We have had the pleasure of receiving the latest Wallace & Tiernan bulletins, by title "Vacuum 'Type MSV' Chlorinator," "The Sanitation of Swimming Pools," "Chlorine in Sewage Purification," "Chlorination of Small Water Supplies" and "Wallace & Tiernan Highway Flashers." The use of chlorine in the disinfection of sewage is increasing, and a perusal of the Wallace & Tiernan bulletin dealing with this application of their products is recommended to all engineers and officials dealing with the and a perusal of the Wallace & Tiernan highway flashers are dry battery operated. The booklet includes specifications, drawings and typical layouts. A traffic engineer in the employ of the company is at the service of all municipalities having traffic problems. The Wallace & Tiernan publications are attractive typographically, delighting the eye at the same time as the mind is instructed by the subject-matter. Wallace & Tiernan Co., Inc., Newark, N. J., will be glad to send you copies.

Rotary Positive Blowers.—The P. H. & F. M. Roots Co., of Connersville, Ind., has just issued a new 16-page bulletin, No. 22-B1, on low-pressure type rotary positive blowers. The bulletin covers the new Roots modernized blowers, equipped with Timken, SKF or Hyatt bearings. The bulletin includes a dimensioned print, a table of sizes giving speeds, capacities and horsepowers at various pressures and a brief review of various types of pumping units. Bulletin 22-B1 replaces the former bulletin 1011 issued by this company, and is so constructed as to make it a valuable addition to the large Roots catalog covering pumps, meters and blowers. Write to the manufacturers for a copy.

Pioneer Gravel Equipment.—The Pioneer Gravel Equipment Mfg. Co., with offices in Minneapolis, Minn., will be pleased to send you literature and catalog describing the Pioneer gravel equipment line, which features portable screening, crushing and loading plants. The Pioneer line includes eleven sizes of crushing plants and five distinct sizes of gravel loading plants. In addition, the line includes draglines, shaker and revolving screens, belt conveyors, in three widths and several sizes of gravel storage bins.

Vertical Gas Engines.—Bulletin 782 of the Chicago Pneumatic Tool Co. describes the type RHG 75 vertical gas engines manufactured by this company. This is really a diesel engine adapted to the use of gas as a fuel. The booklet contains dimensioned drawings and photographs. The manufacturers will

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

An Improved Method of Maintaining and Building Up Gravel Roads

Secondary roads, such as gravel, which are treated with Standard Asphalt Road Oil by the mixed in place method result in smooth riding, economical surface.

The North Star Road in Gratiot County, Michigan, was treated with one and one-half gallons per square yard of Standard Asphalt Road Oil. The Road Oil and aggregate were bladed and mixed on the road with multiple blade maintainers until each particle was uniformly coated. The Road Oil was applied in three applications.

Upper left: First application of Stanolind Road Oil.

Lower left: Bladed roadway ready for second application of road oil.

Upper right: Blading roadway after first application of road oil.

Lower right: Completed roadway.

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be glad to send you a copy. This company maintains an engineering department placed at the service of the customer to assist in solving difficulties and to make recommendations. Service branches are widely distributed and skilled service men are quickly available.

Bilge Pumps.—Bulletin B-3400 of the Yeomans Brothers Co., 1433 Dayton St., Chicago, presents the Yeomans line of heavy-duty bilge pumps. These pumps are built in single and duplex types and can be furnished with regular equipment or with a number of special features such as slow-speed motors, high water alarms, pipe casings for floats, automatic oil economizers, etc., which increase still further the reliability and durability of the machines. Drawings and data tables are included. Write to the manufacturer for a copy.

Servicised Products.—Catalog No. 12 of the Servicised Products Corp. has just come from the printer. This book deals with expansion joints in a rather brief but fairly complete manner, and treats exhaustively of other Servicised products of later development. Most important of these are fibrated asphalt planking, industrial flooring, rail filler, highway crossings and protection course for waterproofing. Readers interested in any way in waterproofing protection materials for use in connection with concrete construction for any purpose will find much that is interesting in the new Servicised catalog. Servicised expansion joints are treated completely in Servicised catalog No. 11, which is also available.

Water Wheels.—Bulletin W203 of the James Leffel & Co. is the first of a series being prepared on typical Leffel water wheel installations. This bulletin features the open penstock installation with submerged type gate operating mechanism. Inasmuch as the details in most water wheel installations are entirely covered by concrete or water, or both, the illustrations shown in this and succeeding bulletins will be of particular interest to users of water wheels. Write to the James Leffel Co., Springfield, Ohio, for a copy.

Power Graders.—A new folder from the W. A. Riddell Co., Bucyrus, Ohio, describes the Warco model "E" and "ER" power graders. Detail photographs and specifications are presented. The manufacturers will be pleased to send you a copy.

Meter Boxes, Valve Housings, Etc.—A new ten page folder has just been received from H. W. Clark Company, Mattoon, Ill., illustrating and describing their gray iron products. The meter boxes are equipped with Wonder Lock, the key serving as handle of box, which cannot be removed without locking box. Products shown are: Meter boxes, box covers, wonder lock, valve boxes, valve housings, extension rings, repair lids, service box wrenches, etc. Illustrations clearly bring out the advantages of these products.

Airports.—"Getting on the Air Map with Caterpillar" is the title of a very attractive booklet issued by the Caterpillar Tractor Company, San Leandro, Cal. Booklet states: "There are more than 1,000 airports in the U. S.—some still in the making. The country needs 10,000." Booklet gives much interesting information concerning what is being done in various parts of the country to meet this need. Send for a copy, kindly mentioning our magazine.

Foundries.—Three folders, of special interest to foundry men, have just been issued by the Link-Belt Company, 910 S. Michigan Avenue, Chicago. These booklets describe the Continuous Malleable Foundry of the Saginaw Malleable Iron Division of General Motors Corporation; the three foundries of the American Manganese Steel Company, and the Link-Belt Vibrating Screen. The Link-Belt Company will be pleased to send copies upon request. If writing kindly mention our magazine.

Sluice Gates.—W. C. A. No. 32 issued by Rodney Hunt Machine Company, 101 Lake Street, Orange, Mass., gives some valuable information on sluice gates and hoisting equipment. This company, manufacturers of water controlling apparatus, will be pleased to give you detailed information about their hand operated, motor operated and hydraulic cylinder operated hoists and stands and accessories for all types of sluice gates, wide bronze facings, eliminating corrosion.

Concrete Pipe.—A very attractive book, giving much useful information on the sanitary engineering field as it applies to concrete pipe, is that issued by the Independent Concrete Pipe Company of Indianapolis, Ind. It is printed on heavy enamel paper, with many clear and comprehensive illustrations and is stitched into a heavy cardboard cover of pleasing appearance, putting the information into permanent form. In addition to a short history of the field, it gives the design, specifications and manufacturing methods of Independent Reinforced Concrete Pipe. The illustrations show manufacture and installations in places described.

Reinforced Concrete Pipe.—A pamphlet issued by the Lock Joint Pipe Company of Ampere, N. J., gives complete description and illustrations of reinforced concrete pressure pipe, which is of three kinds, poured pipe, cylinder pipe and centrifugal pipe and with expansion joints of two types, "Lead and Iron Joint" and "Lead and Steel Joint." All forms are steel held by cast-iron rings, insuring great accuracy and especial smoothness. In addition to photographic illustrations booklet contains several blue print drawings. Copies may be secured from eastern office, or from Chicago branch at 110 S. Dearborn Street.

Wrought Iron.—The A. M. Byers Company, Pittsburgh, Pa., has issued in handsome pamphlet form a reprint from World's Work "The New Story of Ancient Wrought Iron," by Donald Wilhelm. This is a story of the making of wrought iron from the earliest record down to the Aston Process put into practice last year by the A. M. Byers Company at their plant near Warren, O., and for which a new plant is being constructed at Ambridge, Pa. The manufacturer will no doubt be pleased to send copy of this reprint to anyone interested.

Street Department Supplies.—Catalog No. 31 issued by the Safety Gas Main Stopper Company, 523 Atlantic Avenue, Brooklyn, N. Y., bound in loose leaf type, illustrates and describes a long list of products including gas main bags, main plugs, stoppers, gauges, pipe cleaning brushes, cylindrical stoppers for water mains, etc. The new gauge and gas bag valve combination eliminates guess work in the use of inflatable bags and stoppers on which a pump is used. The pressure gauge shows when the pressure is sufficient and whether the bag is holding or losing air.

Mixer.—Koehring Company, Milwaukee, Wis., will be pleased to send you a special circular on the Koehring Weigh Mix, a standard heavy duty mixer with weighing batch hopper and water tank mounted on an auxiliary frame. All operations are controlled from platform, all aggregate is weighed in one hopper and water weighed on same beam.

Deep Well Power Plant.—The United Iron Works, Inc., Tulsa, Okla., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems.

Small-Turbine Leaflet.—"Westinghouse Geared Turbine-Generator Units" is the title of a recent release of the Westinghouse Electric and Manufacturing Co. The pamphlet, No. 20378, includes material on the general features and construction of the new 25 to 50-kw. d-c. geared turbine-generator sets. Photos and drawings show assembly, parts and special devices of the new units. The available ratings with dimensions are also included.

Rust Preventive.—Write to the Chipman Chemical Engineering Co., Inc., 136 Liberty St., New York, N. Y., for booklets describing Atlas marine products. Atlas "Ruskilla" is a quick drying iron and steel paint which contains positive rust-destroying chemicals. It has the ability to stop rust action beneath it.

Pumicite.—Pumicite, an additive to the materials of ordinary concrete, producing a denser, more workable mix, is discussed in a booklet issued by the Pumicite Co., St. Louis, Mo. Every concrete user should be acquainted with the facts cited in this booklet. Write for a copy.

Water Meters.—For literature on water meter setting and testing equip-

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1,500,000 gallons

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Pittsburgh-Des Moines steel tanks are especially designed for municipal water works, and have furnished water storage to many communities for over thirty years.

An elevated water storage tank takes care of the water consumption during the peak hours and insures a constant pressure at all times. It eliminates fire hazards when repairs are being made at the pumping plant.

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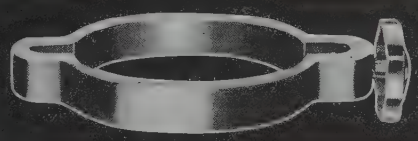
PITTSBURGH DES MOINES

CLARK METER YOKES

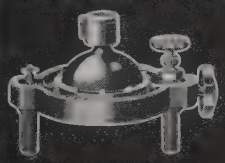


Because of its circular construction, the Clark Meter Yoke offers the advantages of great strength combined with light weight.

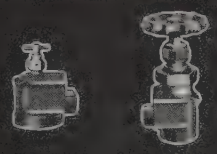
While it holds the meter and riser pipes in a rigid position—it permits of expansion and contraction due to changing temperatures.

When used with Clark Meter Coupling Control Valve and Test Cock—it makes the ideal meter setting.

Meters may be installed or removed in a few seconds—and without the aid of tools. When a yoke is removed the unauthorized use of water is positively eliminated.



Meter installed in Type 4 Clark Yoke. Meter may be installed or replaced in a few seconds without tools.



Clark Control Valve (left) made of high grade bronze. Showing Test Cock (right) of bronze. Needle point type.

Send your specifications for water distributing equipment to

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Meter Couplings

Service Boxes
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Valve Boxes and Housings
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H. W. CLARK COMPANY

Manufacturers of Water Works Necessities

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ment write to the Ford Meter Box Company, Wabash, Ind. Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently.

Sewer Cleaning Machine and Rods.—W. H. Stewart, P. O. Box 581, Jacksonville, Fla., and branches in St. Louis and Boston, as well as factory in Walkerville, Ontario, will be pleased to send literature describing his sewer cleaning machine and conduit rods. Folder describes the hand power machine or the Wonder Bucket equipment. Sewer rods are also illustrated and described, and a list of hand tools for use with sewer rods. This sewer cleaning device will remove anything possible to get into a sewer and clean thoroughly with the least possible difficulty.

Zeolite.—The Zeolite Chemical Company, 140 Cedar Street, New York City, will be pleased to send you "Softening Municipal Water Supplies by the Use of Zeolite," a booklet which describes green sand, a natural base exchange Zeolite mineral, used for water softening. Much interesting information is given.

Stillson Wrenches.—Sando Original and Moroco Popular Stillson wrenches, formerly made by the Moore Drop Forging Co. of Springfield, Mass., are now manufactured by the Trimont Manufacturing Company, 55 Amory Street, Roxbury, Boston, Mass. The Sando has a drop forged handle and jaw, and is scientifically hardened for maximum strength. Handle is made in wood or steel type. Both Sando and Moroco are described and sizes and prices given in booklet which will be sent by manufacturer upon request.

Fire Hydrants and Valves.—The Mathews Fire Hydrants built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia, Pa. A broken Mathews can be replaced is a very few minutes and without excavation or breaking up the pavement. Manufacturer will be pleased to send you full information.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., have had reprints made of a paper by Harry F. Ferguson (chief sanitary engineer, division of sanitary engineering, department of public health, Springfield, Ill.), and Clarence W. Klassen (assistant sanitary engineer, division of sanitary engineering, department of public health, Springfield), and appearing in the January issue of the Journal of the American Water Works Association. The title of the paper is "Are Your Wells and Reservoirs Contaminated?" The report treats of sources and reasons for water contamination, and states: "If owners of public water supplies overlook * * * or permit * * * contamination to continue * * * such owners * * * would be liable for damages for any illness * * * in accordance with recent court decisions." Wallace & Tiernan Co., Inc., will be pleased to send you a copy of this reprint, together with their technical bulletins describing their Chlorinators. Chlorination in the instances cited in the report would have protected the public health. Write for this literature.

Traffic Signals.—Catalog No. 129 has been issued by the Interflash Signal Corporation, 120 Broadway, New York City, describing Interflash "U. S. Standard" road signs and beacon signals for day and night service. Catalog describes the various types illustrated for use on highway and at street intersections where only a warning or cautionary signal is required. These are operated by either self-contained acetylene gas flushing equipment or direct from electric power lines. If interested in all-electric type of control signals ask for Catalog No. 229. For navigation lights for lighthouses, towers, buoys, wharves, bridges, etc., write for Catalog No. 329.

Chemicals.—The Kalbfleisch Corporation, 200 5th Avenue, New York, will be pleased to send you booklet on this subject in its connection with industries. The booklet is very handsome appearing, containing 84 pages, the first part being devoted to the sources, manufacture and uses of chemicals, together with a long list manufactured by the company—industrial and miscellaneous chemicals. The tables at the back of the book give atomic weights, corrections for temperatures and many other tables to serve the chemical user.

Hot Process Water Softener.—A new 12 page catalog in loose leaf style, Bulletin No. 5049, has just been issued by the Graver Corporation, East Chicago, Ind., describing their hot process water softener. Catalog gives views of installations and the component part of the softener. Booklet also contains tables showing savings made by use of softener. An extension to the front cover printed in colors enables the reader to refer to it as he reads the text of the booklet. An informative and attractive bulletin.

Paint Spray Brush.—Simons Paint Spray Brush Co. of Dayton, O., have issued a little booklet describing their paint spray brush and electric and gasoline air compressors to use with it. Containers, fittings, etc., are described and illustrations show the brush at work. For difficult painting jobs, such as large steel water towers, highway bridges, etc., this equipment saves in labor and paint. Ask for a copy of booklet G.

Tractors.—Catalog B-100 issued by Foote Bros. Gear & Machine Co., 215 N. Curtis Street, Chicago, covers all three models of the Bates "Steel Mule" tractor, 30-40-80. The Bates "Steel Mule" is easy to handle, has few wearing parts, and powered by Waukesha motor, it operates at high efficiency at all operating speeds. The crawlers run full length of tractor so it cannot nose into a bank with its radiator. Equipped throughout with IXL-ITE tool hard gears. Booklet fully illustrates, describes and gives specifications of all models.

Fire Hydrants, Gate Valves, Boxes, Indicator Posts, Etc.—A very attractive folder has been issued by the Iowa Valve Company, 701 Hubbell Building, Des Moines, Ia., giving the latest improvements on the products of this company, whose factory is located at Oskaloosa, Ia. Particular attention is called to the many improvements in the fire hydrant, such as the positive mechanical drip valve, bronze working parts, rubber mounted valve, new and improved adjusting feature which insures main valve in line with seat, all working parts removable through top of standpipe without use of special wrench or tripod, unrestricted water flow, delivering full pressure and simple construction. Folder gives description and illustration of fire hydrant and many of the other products of the company.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., manufacturers of chlorine control apparatus, will be pleased to send you full information concerning their MSP Chlorinator. This equipment in duplicate is protecting hundreds of small cities by safeguarding their water supply. Records of cities where this method is in use will be furnished as well as much interesting information concerning sterilization of water.

Centrifugal Pumps.—Booklet W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., contains much interesting information concerning their geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. Pumps for general water service, power plant service, sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. Write for literature.

Planning a Waterworks System.—This is the title of a little booklet which the Cast Iron Research Association, Peoples Gas Building, Chicago, will be pleased to send you upon request. No community of 500 persons can afford to continue without a waterworks system, and many smaller towns have excellent systems. Booklet discusses Engaging the Engineer; Plans; Source of Supply; Estimating Requirements; Pumping System; Duplicate Equipment; Storage Supply; Distribution; Pipe; Hydrants; Records; etc.

Sewage Treatment Plants.—Bulletin No. 101, dated February, 1929, has just been received from the Pacific Flush Tank Company, 4241 Ravenswood Avenue, Chicago, or 9 Park Place, New York, describing the Sprinkling Filter Design using the Twin Dosing Tank Equipment. It is a very comprehensive

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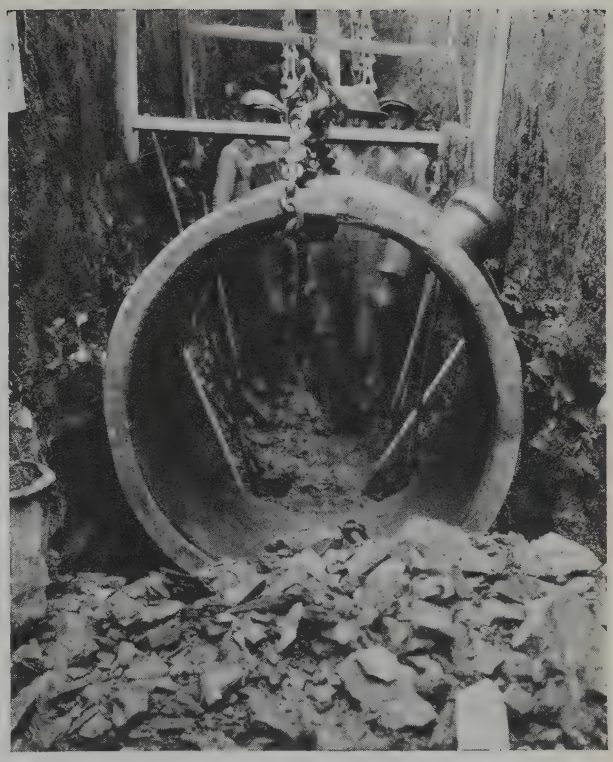

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Norwood Engineering Company
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You might outgrow but you'll never outwear a vitrified clay sewer

CLAY PRODUCTS ASSOCIATION
CONWAY BUILDING
Chicago

VITRIFIED Salt Glazed CLAY
Sanitary Sewer Pipe

WW 9—Gray

presentation of this type of sewage treatment, and contains many detailed illustrations and data concerning large plants in use throughout the country. There are several pages of design data for single and twin tanks with percentage tables. There are also cuts and descriptions of dosing tank counter, nozzles and Marley Tees.

Chlorinizer.—Bulletin No. 20 put out by the Paradon Manufacturing Co., Arlington, N. J., gives full description of Paradon Chlorinizer. Chlorinization is in universal use for sterilization of water supplies, sanitation of swimming pools and for the disinfection of sewage. Operation, advantages, capacity, types of chlorinizers, applicability and specifications are all given in bulletin, and a list of a few typical installations is also included, regarding the Paradon equipment, a chlorinating device for small water supplies, swimming pools, and sewage plants such as in use in small municipalities, factories, camps, estates, country clubs, hotels, etc.

Cast Iron Pipe.—Write to the Central Foundry Company, 420 Lexington Avenue, New York City, for information concerning the cast iron pipe with machined hub and spigot ends, all cast iron, eliminating calking or use of any jointing material. No tool needed but a wrench.

Manhole and Catchbasin Covers.—Wm. E. Dee & Company, 30 North La Salle Street, Chicago, will be pleased to send prices and full particulars concerning their D & D Safety Cover. They guarantee this cover not to rattle or dish.

Diesel Engines.—A bulletin from the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., has been issued describing the diesel power plant at Freeport, L. I., N. Y., where the 6th Busch-Sulzer Diesel—a 1,500 B. hp.—1,050 kw. unit, has just been purchased, making this the largest municipal Diesel plant in the United States, according to statement contained in folder. Their Diesel engines are built in 2-cycle and 4-cycle types, stationary and marine.

Steel Storage Tanks.—Municipal Catalog No. 2 issued by the Pittsburgh-Des Moines Steel Company, 4 Neville Island, Pittsburgh, Pa., give description and information regarding the product of this company for taking care of water consumption during the peak hours and insures a constant pressure at all times. Use of these tanks eliminate fire hazards when repairs are being made at the pumping plant. Information will be furnished concerning complete water works system, pipe lines, reservoirs, filtration, purification, etc.

Fact Book of Steel Construction.—The American Institute of Steel Construction, Inc., 285 Madison Avenue, New York City, has just published a Fact Book which lists the steel fabricators of the United States, Canada, Mexico and Hawaii. It presents in chart and tables the statistics of steel, fabrication and construction work. In addition to presenting data relating to the tallest and largest buildings in the United States it also publishes for the first time the most complete list of steel bridges in the U. S. This book has been brought out because of the now general use of the skyscraper throughout the land and the widespread interest in the fabrication of structural steel.

Porous Concrete Well.—F. Thorpe, 1932 Illinois Avenue, East St. Louis, Ill., will be pleased to send you folder describing this type of well and will furnish a list of references. Some of the outstanding features are length of life, elimination of repair or maintenance costs, satisfied owners, etc.

Toledo Torch.—The new Toledo Torch "Champion" is the product of the Toledo Pressed Steel Co., Toledo, O. Write to the manufacturer for full information as to construction, service and costs.

Steel Sheet Piling.—Address Wemlinger, Inc., Singer Building, New York, or 228 North La Salle Street, Chicago, for information in regard to buying or renting steel sheet piling.

Clay Products.—Wm. E. Dee Clay Mfg. Co., 30 N. La Salle Street, Chicago, manufacturers of standard and double strength sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick, will be pleased to send you full information on any or all of these products.

Sewer Flusher.—Petersen's Hydraulic Flusher Company, 277 First Avenue, Milwaukee, Wis., will be pleased to send you literature illustrating and fully describing their sewer and pipe flushers. It is made in three styles of heavy grade canvas and waterproof tubing. A labor saving tool for city, contractors and manufacturers, and an economical way of clearing sewers.

Cast Iron Pipe.—An attractive folder from the McWane Cast Iron Pipe Company of Birmingham, Ala., and Provo, Utah, shows many successful uses for this pipe. It is used in parks for feeding sprinkling systems, by railroads in yards for water, air and low-pressure steam lines, etc., all of the 2-in. size. It is also made in 4, 6, 8, 10 and 12-in. sizes. Manufacturer will be pleased to send literature illustrating and describing pipe in all sizes for all uses.

Pumps.—Bulletin P-29 issued by the Jaeger Machine Company, Columbus, O., gives illustrations, specifications and full description of diaphragm, plunger type, lift and force centrifugals. The Speed Boy is a 4-cycle high speed engine with foot starter coupled with non-clogging big volume pump with Jaeger open type brass impeller that handles 25 per cent to 28 per cent solid matter such as sand, mud or solid stones. Write for this bulletin.

Cast Iron Pipe.—A very attractive booklet called "Small Diameter Cast Iron Pipe" has just been issued bearing the name of the American Cast Iron Pipe Co., Birmingham, Ala. Types of small diameter pipe described in booklet include: Simplex Prepared Joint Cast Iron Pipe; Two-Inch Bell-and-Spigot Cast Iron Pipe; Two-Inch Prepared Joint Cast Iron Pipe; Threaded-End Cast Iron Pipe; Doublex Simplex Cast Iron Pipe; Flanged Cast Iron Pipe; Cast Iron Pipe for Vitaulic Joints; Bronze Welded Joints and Small Diameter Cement Lined Pipe. Booklet is printed on heavy enamel paper and has an extra heavy cover.

Calatom.—An admixture for concrete which is mined, milled and refined exclusively by Monterey Products Company, Monterey, Cal., and distributed east of the Rocky Mountains by Tamms Silica Company. Calatom is a low water absorption diatomaceous earth for workability and waterproof concrete. Write to the Tamms Silica Company, Stock Exchange Building, Chicago, Ill., for literature giving complete information concerning this powered admixture.

Deep Well Water Systems, Etc.—Alamo Engine Company, Hillsdale, Mich., has issued a very attractive 60 page booklet in loose leaf style, describing the use of Alamo-Dorward Rotary Power Head, for operating deep well and other types of reciprocating plunger pumps. Booklet contains cross sectional drawings, explanation of capacity table captions with several pages of capacity tables.

Meter Boxes, Couplings, Testers, Service Boxes, Etc.—Catalog No. 24 issued by H. W. Clark Company, Mattoon, Ill., gives full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for accessibility for repair work or replacements. Full particulars furnished on all equipment.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Cast Iron Pipe.—"Spi-Cor" is the title of a little booklet issued by the American Casting Company, Birmingham, telling the story of a new era in "culverting." It gives much interesting information in condensed form on spiral corrugated cast iron pipe. If writing for booklet, kindly give the name of our publication.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Water Works and Sewerage, 221 E. 20th St., Chicago.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Gardner-Denver Increases Plant at Quincy

It is reported that contracts were let this week for the new building addition of the Gardner-Denver Co. plant at Quincy, Ill. This will give a 50 per cent increase in production and it is expected it will be finished in 90 days.

Unfilled orders of the company have not diminished, it was announced today by Ralph G. Gardner, vice-president. With additional manufacturing space this fall, production will soon be much nearer the sales demand, he said.

The Gardner-Denver Co. also has plants at Denver, Colo., and Quincy, Ill. It manufactures slush pumps, air compressors, pneumatic tools, drill sharpeners and high pressure drill steel forges.

Herbert Kennedy Company to Represent Michigan Valve in Eastern Territory

The Michigan Valve & Foundry Company have recently appointed the Herbert Kennedy Company of 22 E. 42nd St., New York City, their representatives in New York, Massachusetts, Vermont, Connecticut, New Hampshire, Rhode Island and Maine to cooperate with municipal executives and engineers in the supply of valves, hydrants, sluice gates and other appurtenances for water works, filtration and sewerage systems.

The Herbert Kennedy Company are also the selling agents in the United States for the Pont-A-Mousson Cast Iron Foundries at Nancy, France, the largest complete unit in the world devoted exclusively to the production of cast iron pipe and fittings.

The extensive properties of the French company at Pont-A-Mousson during the war were practically in the front lines of the French army and received a good deal of attention from the German artillery just prior to the advance of the American first army in the fall of 1918. During the progress of these military operations the foundry was completely destroyed and not again re-habilitated until after 1921. Since then, however, it has been completely rebuilt and thoroughly equipped with the most modern equipment. It is now producing in excess of 500,000 tons per year.

The Herbert Kennedy Company will also represent, as exclusive selling agents, the Inter-Continental Pipe & Mining Company, now constructing a large pipe foundry at Chelsea, Mass.

In anticipation of the distribution of products from the new unit, the Herbert Kennedy Company will expand their sales organization, which for the past five years covered only the seaboard states. As soon as the Chelsea plant gets under production, this sales organization will have been made national in scope.

The Herbert Kennedy Company has always specialized in products sold to municipalities and public utilities and are consequently prepared to cooperate to the fullest extent with the officials responsible for the purchasing and operation of water works and sewerage equipment.

Changes in Link-Belt Personnel

From the executive offices of the Link-Belt Company comes the announcement of the resignation of Mr. F. B. Caldwell, vice-president of the Chicago plant, on account of health.

Mr. W. C. Carter, formerly vice-president in general charge of production at all Link-Belt plants, will assume the duties of vice-president and general manager of the Chicago plant.

Mr. E. J. Burnell, who was manager of the Pittsburgh office, has been appointed sales manager of the Western Division, with headquarters at the Chicago plant.

Mr. Nels Davis, from the Chicago engineering sales force, succeeds Mr. Burnell.

W. C. Carter, Recently Made General Manager for Chicago Plant of Link-Belt

Ray P. McGrath

On September 3rd, Mr. Ray McGrath, who for fifteen years has been manager of the San Francisco office of the Sullivan Machinery Company, passed away.

Mr. McGrath has been associated with the Sullivan Company since 1906. He was connected with the New England sales office of the company at Boston until 1914, when he was appointed manager at San Francisco. He was one of the most widely liked and most highly respected members of its sales organization, and his death is a great loss to his company and host of friends.

New Representative In East for Trimont

W. K. Hughes, who for the past ten years has represented Peck, Stow & Wilcox Company in the Pennsylvania and Atlantic seaboard territory, has become associated with the Trimont Manufacturing Company of Roxbury, Mass. This company is well known as makers of Trimo tools.

Mr. Hughes will represent the Trimont Company as a direct representative in charge of eastern sales.

Change of Address

The Houston office of the Chain Belt Company, Milwaukee, manufacturers of Rex deep well oil chains, conveyors and concrete mixers, has moved to larger quarters at 1310 Second National Bank Building. They were formerly located at 1000 Marine Bank Building. Mr. Russell G. Davis is manager.

Paradon Appoints New Representative for Southwest Territory

The Paradon Manufacturing Company of Arlington, N. J., announces the appointment of Mr. Roy E. King as assistant to Mr. L. K. Cecil, 214 Atco Building, Tulsa, Okla., sales representative for the Paradon chlorinators in the states of Arkansas and Oklahoma.

Mr. King has just recently returned to Tulsa from the factory at Arlington, where he underwent a thorough training in the servicing of Paradon chlorinators.

The U. S. Piper, the attractive quarterly paper of the United States Pipe & Foundry Company, Burlington, N. J., presents a story of the installation of a 60-in. cast iron pipe line to insure abundant water supply for Atlantic City.

Japanese Quick to Adopt Modern Methods

The New Nomura Bank in Tokyo is an example of the enthusiasm and readiness with which the Japanese adopt modern ideas. A correspondent for the Chicago Pump Company, manufacturers of the well known "Flush-Kleen" Ejector, writes:

"The Japanese, after being convinced of the merit of an idea, are quick to adapt and use that idea.

"In evidence of the Japanese progressive attitude, we cite their use of the same materials and methods in their new buildings as we use over here. Japan, because of its enthusiasm and readiness to use modern ideas, makes that country a splendid field for American products."

One type of American product used in the new bank is the "Flush-Kleen" Ejector, which uses the flow reversal principle of ejector.

Link-Belt Appoints Distributors

Link-Belt Company of Chicago have just completed negotiations with several organizations throughout the country to act as sales agents for their complete line of cranes, shovels and draglines.

Mr. Charles L. Miller, of Denver and Salt Lake City, will handle Utah, Colorado and the Intermountain territory.

In Alabama, Mr. James Van Buskirk, 911 Martin Bldg., Birmingham, will purvey this equipment.

The Clyde Company, located at 309 Magazine St., New Orleans, are now taking care of the business throughout the state of Louisiana and the south half of Mississippi, with the exception of a few counties in the very southeast corner.

In a radius around Memphis, Tenn., the Holloran Tractor Company at 188 Butler Ave., that city, will now tell you about this complete line of machines.

The territory of Greater New York, including Westchester, Nassau and Suffolk Counties, can learn from the United Hoisting Company, 136th and Locust Sts., New York, facts and interesting data about Link-Belt machines.

Ensminger & Company, 181 S. Washington St., Wilkes-Barre, Pa., are well posted on the entire line of Link-Belt cranes, shovels and draglines, and will be pleased to tell you about them.

Copies of the Crane Book, recently issued by Link-Belt, may be obtained through any of these agents. This book shows many novel and practical uses for their line of equipment. These agents will also be glad to have the publication "Shovel News" sent readers gratis. It is devoted to the use of these machines and is issued every other month.

Cleveland Tractor Company at the National Air Races

Model "100" Cletrac, handsomely decorated, and representing POWER, constituted the entry of the Cleveland Tractor Company in the parade of floats and marching units depicting Cleveland's industries and organizations in the pageant on the opening day of the National Air Races and Exposition held in Cleveland recently.

The parade started five miles out and moved down historic Euclid Ave., with the Public Hall the final destination and disbanding point. The races and field events took place at the Cleveland Airport, and the exposition of airplanes together with all kinds of aeronautical equipment was staged in Cleveland's mammoth Public Hall.

Sullivan Office at Huntington Changes Local Address

The Sullivan Machinery Company's branch office and warehouse at Huntington, West Virginia, were moved September 1, from their old address at 736 Third Avenue to new quarters at 702-704 Eighth Avenue.

The new location gives additional space and convenience for the office, and better warehouse facilities, as it is on a side track and near the C. & O. Railroad station. A considerable stock of Sullivan Coal Mining equipment and spare parts is maintained at Huntington; also of air compressors and drills.

The Contract Drilling Department of the company also maintains a depot at this point for Diamond Drilling equipment, and supplies necessary service for prospecting jobs in Virginia, West Virginia, Eastern Kentucky and Tennessee.

Mr. J. S. Walker, Jr., is manager of the Huntington office.

W. S. Leech Joins Basford Company

Willoughby S. Leech, well known in Pittsburgh, through his former sales and advertising connections with some of the large manufacturing companies in that district, including Westinghouse Electric & Manufacturing Company and A. M. Myers Company, has joined the staff of G. M. Basford Company.

To care for the expanding business among the industrials of western Pennsylvania and Ohio the Basford Company has opened a branch office in the recently completed Koppers Building, Pittsburgh, where Mr. Leech will be permanently located. The counsel of Mr. Leech on advertising matters is available to all clients of the G. M. Basford Company.

Thank You

We are glad that Mineralead is supplied in solid form, for it has come to us as a very attractive and useful paperweight, the editor's best friend in a windy city. It is now at work holding our papers together, and we thank the manufacturer, The Atlas Mineral Products Company of Mertztown, Pa.

However, paperweighting is not the real purpose of Mineralead for it was developed by its sponsors as a jointing material for Bell and Spigot cast iron pipe. They will be glad to tell you all about it, and if you can use a paper weight maybe the manufacturer will send you one, too.

The Paradon Manufacturing Company, Arlington, N. J., announces the appointment of Mr. William H. Fulton as chief engineer of the company. Mr. Fulton will have full charge of the design and development of Paradon Chlorinating apparatus and other projects of the company.

Contract Welding

A man experienced in Oxy-Acetylene welding would like yearly contract with supply company for making welded product on small scale. Name furnished upon request.

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addesses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for northern California terirtory. Now stocking equipment for several well known machinery manufacturers.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

District representative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Civil engineer located in Porto Rico would like to hear from manufacturers desiring sole representation for their products in Porto Rico, Santo Domingo and Venezuela. Machinery for highway construction, purification plants, steel for buildings or bridges or other building materials and contractors' equipment.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two-cycle oil and gas engines, in sizes from 30 to 125 hp., adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Attractive territory available for experienced men to handle contractors' labor-saving equipment by old established company. Equipment backed by national advertising.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

Manufacturer has some attractive territory available for distributors of complete line of generators, centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the southwest and middlewest.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of rotary pump, especially designed for road construction work, has proposition for reliable distribution houses.

Duty-free Foreign Cement Blamed for Shutdown of Norfolk Plant

After operating on a greatly reduced output with several shutdowns during the past winter and throughout the current year, the Norfolk mill of the Lone Star Cement Company Virginia, Inc., and its raw material operations at Chuckatuck closed down for an indefinite period August 10th, executives of the company announced.

Low priced foreign cement admitted duty free under the present tariff schedule was given as the reason for the shutdown.

"We have kept our mills going just as long as we could provide storage space for the cement produced," Mr. Dwight Morgan, vice-president of the company, said in explaining the shutdown. "We have operated at a reduced capacity for over a year in an effort to keep as many men as possible on the payroll over an extended period. Now we face the accumulated effect of the continued and extensive use of imported cement by highway contractors and industrial constructors in South Carolina, by the state of North Carolina for its highway work and the awarding of the Richmond, Va., city contract this year to foreign cement.

"At a time when normal building activity should keep our mills working to capacity to meet the demand we find our storage bins filled and therefore have no alternative. We must temporarily stop production.

"The wage scale paid the European cement worker is approximately one-fifth the wage scale paid the Virginia cement worker," Mr. Morgan said. "Belgium has been the principal exporter to the United States, and cement from that country as well as from other foreign countries, does not carry any import duty. The result is, well-paid American workmen are placed in direct competition with poorly paid Belgian workmen. Cheap labor plus low transportation cost makes it possible for the foreign manufacturer to offer his product in the seaboard territory at a lower price than we can meet.

"The result of this competition is not felt in the cement industry alone, nor in Norfolk alone. Most cement manufacturers on the Atlantic seaboard, Gulf Coast and Pacific Coast have been operating at a reduced output for several years, with many cement workers unemployed.

"The Lone Star Cement Company Virginia Inc., like other American cement manufacturers, has contested the invasion of their legitimate market, by reducing prices to a point where there is little or no profit. We have made well-founded appeals to the loyalty, as well as the self-interest, of the American public—pointing out the fact that the disruption of the cement industry affects not only the cement worker, but has an effect on co-related industries, and on retailers, wholesalers, and manufacturers who must depend upon workers in these industries for their trade.

"Until we are successful in our efforts to maintain our rightful markets by securing an import duty on cement, now pending before Congress, that will equalize the overwhelming difference in wages and protect the American workman from unfair competition that is undermining the American standards of living, we cannot operate our mill. We have done everything possible to keep our men employed—but now that our bins are filled we have no choice—the mill must close."

Editor's Note: The editorial policy of the Gillette publications has always been opposed to the use of foreign cement.

No Race Suicide Here

The Mueller Company organization of Decatur, Illinois, finds time for work and play and also to care for the babies, as is evidenced by the report of the annual outing which took place recently at Fairview Park. From as early as 8 o'clock in the morning till the Home Sweet Home of the dance in the evening the spirit of fun and fellowship prevailed.

According to reports, the children came in for paramount consideration. Sixteen Shetland ponies were kept busy throughout the day providing free rides, an ever popular feature with little folks.

There were seventy-two entries in the baby show, all children of Mueller employees and all born since the last picnic. The judges with the wisdom of long experience were unable to agree upon a winner, and all babies were awarded a prize, being given a bank book and $1.00 to start a savings account. At the end of the year another $1.00 is to be added, provided the baby has been thrifty and saved a like amount.

Another interesting provision made for the babies was introduced by Mr. Adolph Mueller, when, about a year ago, he purchased for the welfare department a hundred fine baby cribs, which are loaned to mothers, wives of employees. When the cribs are returned, they are redecorated and ready for another loan. The fact that these cribs are kept in constant circulation, explains our title.

In addressing the gathering (about 5,000), Mr. Mueller called attention to the modern trend of large industries, pointing out the movement to the smaller cities where better opportunities and better living conditions prevail. The spirit of loyalty shown by the men for the company was touched upon, and B. J. Marty and W. H. Campbell who have been with the company 35 years and who were given a trip west, told some of their experiences.

Walter Knapp Made Executive Engineer for DeWalt Products

The DeWalt Products Corporation of Leola, Pa., announces the addition to their organization of Mr. Walter Knapp, as the executive engineer of their plant.

Mr. Walter Knapp is a mechanical engineer, graduated from Cornell University, and has had many years experience in plant engineering in all of its phases—in such important fields as research engineering, design development, and production engineering, including methods and personnel management.

Mr. Knapp, while associated with the General Electric Company, accomplished very important organization work in the establishment of wage incentive plans, being one of the first in the country to introduce group incentive, and is recognized as an authority of standing in this field.

This corporation is developing an organization of high standing in the production of high speed cutting equipment for wood, metal, and stone. Departments in research engineering and design engineering are reaching a high state of efficiency; and production is being organized in keeping with the most forward practice in the manufacturing of machinery today.

New Oxygen Plant Opens in Erie

A new Linde Oxygen plant located at 1628 Cascade Street, Erie, Pa., commenced operations August 21, 1929. This plant will supply the local demand for oxygen, widely used for oxy-acetylene welding and cutting.

Mr. J. J. McKeen is superintendent of this plant and Mr. R. S. Hamilton, whose headquarters are at the East Buffalo Linde plant, is district superintendent.

Change of Address

The Central Iron & Steel Company of Harrisburg, Pa., announces a change in the address of their Boston office which will from now on be Statler Office Building, Park Square. The office has been removed from the former location at 131 State Street. Mr. G. T. Armstrong still remains in charge.

This company manufactures the well known Central Floor Plate, as well as steel sheets and stampings.

Experienced Salesman Wanted

Manufacturer of contractors' equipment has opening in Chicago territory for an experienced salesman. This is a position of some responsibility and applications from high grade men are desired. Editor will be pleased to furnish name upon request.

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Snow Fence.—A snow fence designed to prevent over topping by drifts is described in literature issued recently by the Northfield Iron Co., 494 Nico St., Northfield, Minn. It is stated that the fence is so constructed that when set at about a 30 degree angle it shoots the wind down to the ground, piles snow twice the height of the fence, and keeps drifts away from the fence. The fence is made of 6 in. wide 8 ft. 5½ in. long pressed steel boards, with painted steel angle posts, 2 in. x 1½ in. x 6 ft. long. The pressed steel boards for 1,000 ft. of fence make a pile only 26 in. high, 6 in. wide and 101½ in. long. It is stated that two men can drive the posts and lay up 2,000 to 3,000 ft. of fence per day.

Sewage Chlorination.—Wallace & Tiernan Co., Inc., Newark, N. J., has just mailed to all sanitary engineers, sewage plant operators and public health officials in the United States and Canada, a reprint of the article "Advancements and Developments in Sewage Chlorination" by Linn H. Enslow, research engineer of the Chlorine Institute. The article is published in the standard 6x9-in. size used by Wallace & Tiernan for this type of educational publicity. It should be of value to all who are interested in sewage chlorination.

Trailers.—Highway Trailer Co. has recently issued a pamphlet illustrating the many ways in which their trailers serve the public utilities. Contractors in any field will receive many profitable suggestions from this release, which the manufacturers will be pleased to supply.

Deep-Well Pumps.—The "Moturbo Water Boy" is a deep-well turbine pumping unit, specially designed and built to serve the domestic requirements of farmers and the needs of private estates and small industrial plants. Write to the Peerless Pump Co., 1902 E. Sixty-seventh St., Los Angeles, Calif., for a folder describing this unit. The manufacturers will be pleased to advise you concerning your water requirements.

Spreaders.—Bulletin No. 101 of the Stolle Road Equipment Co., describes the Stolle "Senior" spreader for road material. This spreader may be attached to any dump truck and will operate equally well irrespective of the direction in which the truck travels. The folder contains photographs of the spreader in action and instances of the savings effected through its use. Write to the Stolle Road Equipment Co., Inc., 321 South Grand Blvd., St. Louis, Mo., for a copy.

Knickerbocker Mixers.—Catalog No. 29 presents the complete line of Knickerbocker concrete, mortar, plaster and mastic mixers. A feature of the concrete mixers is the new Knickerbocker device for securing accurate control of the water introduced into the mix. Dimensioned drawings and detailed specifications of the mixers are included. This catalog also describes Knickerbocker saw rigs. Write to the Knickerbocker Co., Jackson, Mich.

High-Early-Strength Cement. — Examples of the saving of time on paving jobs by the use of "Incor" high-early-strength portland cement are cited in a folder recently issued by the International Cement Corp., 342 Madison Ave., New York, N. Y. This corporation is composed of 11 cement companies in the United States, Cuba, and South America, which have a combined output of 20,000,000 barrels of cement annually. Contractors and officials who are interested in minimizing delays caused by construction should write for this bulletin.

Marquette Cement.—"Marquette Super Cement Concrete" is the title of a 24-page booklet recently issued by the Marquette Cement Manufacturing Co., Chicago, Ill. Various jobs in which Marquette cement has been used are illustrated. There is included a brief manual of recommended construction practice, covering the structural use of this manufacturer's product. Write for a copy.

Street and Parking Signs.—A folder from the A. D. Joslin Manufacturing Co., Manistee, Mich., describes the Joslin line of weatherproof street signs. Standard street markers and parking and zone signs are illustrated. Joslin street signs are guaranteed to be readable for 10 years. The makers will be glad to provide you with a folder.

Motor Sweepers.—The Austin motor pick-up sweeper is described in Catalog No. 8, issued by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill. This is a sprinkler-sweeper with oscillating gutter broom and rear pick-up broom. The catalog contains specifications and detailed drawings, photographs and cross-sections of the sweeper. The manufacturers will be pleased to furnish you with a copy.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

Street Signals. — Write to the Rochester Street Signal Co., 400 Ward Building, Rochester, N. Y., for a folder describing "Monroe" and "Simplex" street signs. The "Monroe" unit is the only one in the market that employs no screws, nuts or bolts in the assembling. The fittings are made of aluminum. The sign plates are enameled. Inquiries are invited.

Wallace & Tiernan.—We have had the pleasure of receiving the latest Wallace & Tiernan bulletins, by title "Vacuum 'Type MSV' Chlorinator," "The Sanitation of Swimming Pools," "Chlorine in Sewage Purification," "Chlorination of Small Water Supplies" and "Wallace & Tiernan Highway Flashers." The use of chlorine in the disinfection of sewage is increasing, and a perusal of the Wallace & Tiernan bulletin dealing with this application of their products is recommended to all engineers and officials dealing with the and a perusal of the Wallace & Tiernan highway flashers are dry battery operated. The booklet includes specifications, drawings and typical layouts. A traffic engineer in the employ of the company is at the service of all municipalities having traffic problems. The Wallace & Tiernan publications are attractive typographically, delighting the eye at the same time as the mind is instructed by the subject-matter. Wallace & Tiernan Co., Inc., Newark, N. J., will be glad to send you copies.

Pioneer Gravel Equipment.—The Pioneer Gravel Equipment Mfg. Co., with offices in Minneapolis, Minn., will be pleased to send you literature and catalog describing the Pioneer gravel equipment line, which features portable screening, crushing and loading plants. The Pioneer line includes eleven sizes of crushing plants and five distinct sizes of gravel loading plants. In addition, the line includes draglines, shaker and revolving screens, belt conveyors, in three widths and several sizes of gravel storage bins.

Vertical Gas Engines.—Bulletin 782 of the Chicago Pneumatic Tool Co. describes the type RHG 75 vertical gas engines manufactured by this company. This is really a diesel engine adapted to the use of gas as a fuel. The booklet contains dimensioned drawings and photographs. The manufacturers will

be glad to send you a copy. This company maintains an engineering department placed at the service of the customer to assist in solving difficulties and to make recommendations. Service branches are widely distributed and skilled service men are quickly available.

Bilge Pumps.—Bulletin B-3400 of the Yeomans Brothers Co., 1433 Dayton St., Chicago, presents the Yeomans line of heavy-duty bilge pumps. These pumps are built in single and duplex types and can be furnished with regular equipment or with a number of special features such as slow-speed motors, high water alarms, pipe casings for floats, automatic oil economizers, etc., which increase still further the reliability and durability of the machines. Drawings and data tables are included. Write to the manufacturer for a copy.

Servicised Products.—Catalog No. 12 of the Servicised Products Corp. has just come from the printer. This book deals with expansion joints in a rather brief but fairly complete manner, and treats exhaustively of other Servicised products of later development. Most important of these are fibrated asphalt planking, industrial flooring, rail filler, highway crossings and protection course for waterproofing. Readers interested in any way in waterproofing protection materials for use in connection with concrete construction for any purpose will find much that is interesting in the new Servicised catalog. Servicised expansion joints are treated completely in Servicised catalog No. 11, which is also available.

Water Wheels.—Bulletin W203 of the James Leffel & Co. is the first of a series being prepared on typical Leffel water wheel installations. This bulletin features the open penstock installation with submerged type gate operating mechanism. Inasmuch as the details in most water wheel installations are entirely covered by concrete or water, or both, the illustrations shown in this and succeeding bulletins will be of particular interest to users of water wheels. Write to the James Leffel Co., Springfield, Ohio, for a copy.

Power Graders.—A new folder from the W. A. Riddell Co., Bucyrus, Ohio, describes the Warco model "E" and "ER" power graders. Detail photographs and specifications are presented. The manufacturers will be pleased to send you a copy.

Meter Boxes, Valve Housings, Etc.—A new ten page folder has just been received from H. W. Clark Company, Mattoon, Ill., illustrating and describing their gray iron products. The meter boxes are equipped with Wonder Lock, the key serving as handle of box, which cannot be removed without locking box. Products shown are: Meter boxes, box covers, wonder lock, valve boxes, valve housings, extension rings, repair lids, service box wrenches, etc. Illustrations clearly bring out the advantages of these products.

Airports.—"Getting on the Air Map with Caterpillar" is the title of a very attractive booklet issued by the Caterpillar Tractor Company, San Leandro, Cal. Booklet states: "There are more than 1,000 airports in the U. S.—some still in the making. The country needs 10,000." Booklet gives much interesting information concerning what is being done in various parts of the country to meet this need. Send for a copy, kindly mentioning our magazine.

Foundries.—Three folders, of special interest to foundry men, have just been issued by the Link-Belt Company, 910 S. Michigan Avenue, Chicago. These booklets describe the Continuous Malleable Foundry of the Saginaw Malleable Iron Division of General Motors Corporation; the three foundries of the American Manganese Steel Company, and the Link-Belt Vibrating Screen. The Link-Belt Company will be pleased to send copies upon request. If writing kindly mention our magazine.

Sluice Gates.—W. C. A. No. 32 issued by Rodney Hunt Machine Company, 101 Lake Street, Orange, Mass., gives some valuable information on sluice gates and hoisting equipment. This company, manufacturers of water controlling apparatus, will be pleased to give you detailed information about their hand operated, motor operated and hydraulic cylinder operated hoists and stands and accessories for all types of sluice gates, wide bronze facings, eliminating corrosion.

Concrete Pipe.—A very attractive book, giving much useful information on the sanitary engineering field as it applies to concrete pipe, is that issued by the Independent Concrete Pipe Company of Indianapolis, Ind. It is printed on heavy enamel paper, with many clear and comprehensive illustrations and is stitched into a heavy cardboard cover of pleasing appearance, putting the information into permanent form. In addition to a short history of the field, it gives the design, specifications and manufacturing methods of Independent Reinforced Concrete Pipe. The illustrations show manufacture and installations in places described.

Reinforced Concrete Pipe.—A pamphlet issued by the Lock Joint Pipe Company of Ampere, N. J., gives complete description and illustrations of reinforced concrete pressure pipe, which is of three kinds, poured pipe, cylinder pipe and centrifugal pipe and with expansion joints of two types, "Lead and Iron Joint" and "Lead and Steel Joint." All forms are steel held by cast-iron rings, insuring great accuracy and especial smoothness. In addition to photographic illustrations booklet contains several blue print drawings. Copies may be secured from eastern office, or from Chicago branch at 110 S. Dearborn Street.

Wrought Iron.—The A. M. Byers Company, Pittsburgh, Pa., has issued in handsome pamphlet form a reprint from World's Work "The New Story of Ancient Wrought Iron," by Donald Wilhelm. This is a story of the making of wrought iron from the earliest record down to the Aston Process put into practice last year by the A. M. Byers Company at their plant near Warren, O., and for which a new plant is being constructed at Ambridge, Pa. The manufacturer will no doubt be pleased to send copy of this reprint to anyone interested.

Street Department Supplies.—Catalog No. 31 issued by the Safety Gas Main Stopper Company, 523 Atlantic Avenue, Brooklyn, N. Y., bound in loose leaf type, illustrates and describes a long list of products including gas main bags, main plugs, stoppers, gauges, pipe cleaning brushes, cylindrical stoppers for water mains, etc. The new gauge and gas bag valve combination eliminates guess work in the use of inflatable bags and stoppers on which a pump is used. The pressure gauge shows when the pressure is sufficient and whether the bag is holding or losing air.

Mixer.—Koehring Company, Milwaukee, Wis., will be pleased to send you a special circular on the Koehring Weigh Mix, a standard heavy duty mixer with weighing batch hopper and water tank mounted on an auxiliary frame. All operations are controlled from platform, all aggregate is weighed in one hopper and water weighed on same beam.

Deep Well Power Plant.—The United Iron Works, Inc., Tulsa, Okla., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems.

Small-Turbine Leaflet.—"Westinghouse Geared Turbine-Generator Units" is the title of a recent release of the Westinghouse Electric and Manufacturing Co. The pamphlet, No. 20378, includes material on the general features and construction of the new 25 to 50-kw. d-c. geared turbine-generator sets. Photos and drawings show assembly, parts and special devices of the new units. The available ratings with dimensions are also included.

Rust Preventive.—Write to the Chipman Chemical Engineering Co., Inc., 136 Liberty St., New York, N. Y., for booklets describing Atlas marine products. Atlas "Ruskilla" is a quick drying iron and steel paint which contains positive rust-destroying chemicals. It has the ability to stop rust action beneath it.

Pumicite.—Pumicite, an additive to the materials of ordinary concrete, producing a denser, more workable mix, is discussed in a booklet issued by the Pumicite Co., St. Louis, Mo. Every concrete user should be acquainted with the facts cited in this booklet. Write for a copy.

Water Meters.—For literature on water meter setting and testing equip-

BIG AND LITTLE, RICH AND POOR, CAN PROJECT THEIR PERSONALITIES OVER THE WIDE NETWORK OF ITS WIRES

In the service of all the people

An Advertisement of the
American Telephone and Telegraph Company

THE Bell System is owned by 450,000 stockholders and operated by more than 400,000 workers for the service of the people of the nation.

It is a democratic instrument of a democracy. Big and little, rich and poor, can project their personalities over the wide network of its wires. For friendship or business, pleasure or profit, the telephone is indispensable to our modern civilization.

This year the Bell System is erecting new telephone buildings in more than 200 cities. It is putting in thousands of miles of cable, thousands of sections of switchboard and hundreds of thousands of new telephones. Its expenditure for plant and improvements in service in 1929 will be more than 550 millions of dollars—half again as much as it cost to build the Panama Canal.

This program is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

ment write to the Ford Meter Box Company, Wabash, Ind. Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently.

Sewer Cleaning Machine and Rods.—W. H. Stewart, P. O. Box 581, Jacksonville, Fla., and branches in St. Louis and Boston, as well as factory in Walkerville, Ontario, will be pleased to send literature describing his sewer cleaning machine and conduit rods. Folder describes the hand power machine or the Wonder Bucket equipment. Sewer rods are also illustrated and described, and a list of hand tools for use with sewer rods. This sewer cleaning device will remove anything possible to get into a sewer and clean thoroughly with the least possible difficulty.

Zeolite.—The Zeolite Chemical Company, 140 Cedar Street, New York City, will be pleased to send you "Softening Municipal Water Supplies by the Use of Zeolite," a booklet which describes green sand, a natural base exchange Zeolite mineral, used for water softening. Much interesting information is given.

Stillson Wrenches.—Sando Original and Moroco Popular Stillson wrenches, formerly made by the Moore Drop Forging Co. of Springfield, Mass., are now manufactured by the Trimont Manufacturing Company, 55 Amory Street, Roxbury, Boston, Mass. The Sando has a drop forged handle and jaw, and is scientifically hardened for maximum strength. Handle is made in wood or steel type. Both Sando and Moroco are described and sizes and prices given in booklet which will be sent by manufacturer upon request.

Fire Hydrants and Valves.—The Mathews Fire Hydrants built for easy installation and so that an extension section may be used to adapt them to new grades, are described in literature of the R. D. Wood & Co., Philadelphia, Pa. A broken Mathews can be replaced is a very few minutes and without excavation or breaking up the pavement. Manufacturer will be pleased to send you full information.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., have had reprints made of a paper by Harry F. Ferguson (chief sanitary engineer, division of sanitary engineering, department of public health, Springfield, Ill.), and Clarence W. Klassen (assistant sanitary engineer, division of sanitary engineering, department of public health, Springfield), and appearing in the January issue of the Journal of the American Water Works Association. The title of the paper is "Are Your Wells and Reservoirs Contaminated?" The report treats of sources and reasons for water contamination, and states: "If owners of public water supplies overlook * * * or permit * * * contamination to continue * * * such owners * * * would be liable for damages for any illness * * * in accordance with recent court decisions." Wallace & Tiernan Co., Inc., will be pleased to send you a copy of this reprint, together with their technical bulletins describing their Chlorinators. Chlorination in the instances cited in the report would have protected the public health. Write for this literature.

Traffic Signals.—Catalog No. 129 has been issued by the Interflash Signal Corporation, 120 Broadway, New York City, describing Interflash "U. S. Standard" road signs and beacon signals for day and night service. Catalog describes the various types illustrated for use on highway and at street intersections where only a warning or cautionary signal is required. These are operated by either self-contained acetylene gas flushing equipment or direct from electric power lines. If interested in all-electric type of control signals ask for Catalog No. 229. For navigation lights for lighthouses, towers, buoys, wharves, bridges, etc., write for Catalog No. 329.

Chemicals.—The Kalbfleisch Corporation, 200 5th Avenue, New York, will be pleased to send you booklet on this subject in its connection with industries. The booklet is very handsome appearing, containing 84 pages, the first part being devoted to the sources, manufacture and uses of chemicals, together with a long list manufactured by the company—industrial and miscellaneous chemicals. The tables at the back of the book give atomic weights, corrections for temperatures and many other tables to serve the chemical user.

Hot Process Water Softener.—A new 12 page catalog in loose leaf style, Bulletin No. 5049, has just been issued by the Graver Corporation, East Chicago, Ind., describing their hot process water softener. Catalog gives views of installations and the component part of the softener. Booklet also contains tables showing savings made by use of softener. An extension to the front cover printed in colors enables the reader to refer to it as he reads the text of the booklet. An informative and attractive bulletin.

Paint Spray Brush.—Simons Paint Spray Brush Co. of Dayton, O., have issued a little booklet describing their paint spray brush and electric and gasoline air compressors to use with it. Containers, fittings, etc., are described and illustrations show the brush at work. For difficult painting jobs, such as large steel water towers, highway bridges, etc., this equipment saves in labor and paint. Ask for a copy of booklet G.

Tractors.—Catalog B-100 issued by Foote Bros. Gear & Machine Co., 215 N. Curtis Street, Chicago, covers all three models of the Bates "Steel Mule" tractor, 30-40-80. The Bates "Steel Mule" is easy to handle, has few wearing parts, and powered by Waukesha motor, it operates at high efficiency at all operating speeds. The crawlers run full length of tractor so it cannot nose into a bank with its radiator. Equipped throughout with IXL-ITE tool hard gears. Booklet fully illustrates, describes and gives specifications of all models.

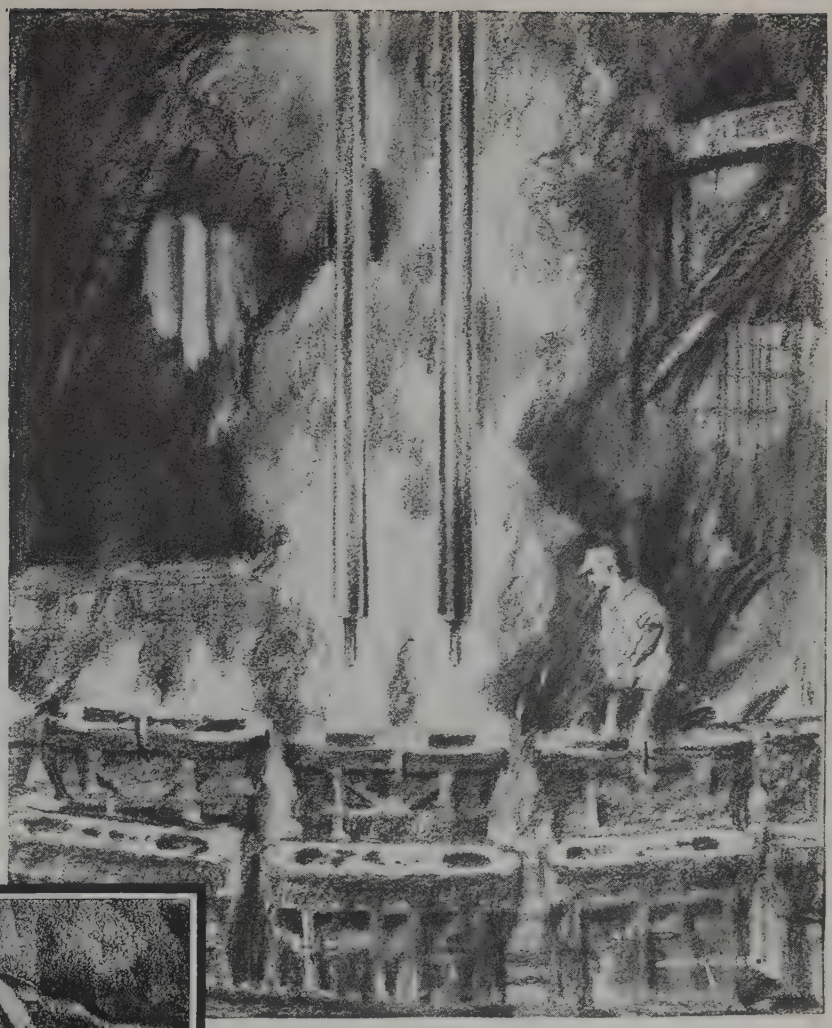
Fire Hydrants, Gate Valves, Boxes, Indicator Posts, Etc.—A very attractive folder has been issued by the Iowa Valve Company, 701 Hubbell Building, Des Moines, Ia., giving the latest improvements on the products of this company, whose factory is located at Oskaloosa, Ia. Particular attention is called to the many improvements in the fire hydrant, such as the positive mechanical drip valve, bronze working parts, rubber mounted valve, new and improved adjusting feature which insures main valve in line with seat, all working parts removable through top of standpipe without use of special wrench or tripod, unrestricted water flow, delivering full pressure and simple construction. Folder gives description and illustration of fire hydrant and many of the other products of the company.

Chlorination. — Wallace & Tiernan Co., Inc., Newark, N. J., manufacturers of chlorine control apparatus, will be pleased to send you full information concerning their MSP Chlorinator. This equipment in duplicate is protecting hundreds of small cities by safeguarding their water supply. Records of cities where this method is in use will be furnished as well as much interesting information concerning sterilization of water.

Centrifugal Pumps.—Booklet W-67 issued by DeLaval Steam Turbine Co., Trenton, N. J., contains much interesting information concerning their geared steam turbine driven pumps, electric motor driven pumps or internal combustion engine driven pumps. Pumps for general water service, power plant service, sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. Write for literature.

Planning a Waterworks System.—This is the title of a little booklet which the Cast Iron Research Association, Peoples Gas Building, Chicago, will be pleased to send you upon request. No community of 500 persons can afford to continue without a waterworks system, and many smaller towns have excellent systems. Booklet discusses Engaging the Engineer; Plans; Source of Supply; Estimating Requirements; Pumping System; Duplicate Equipment; Storage Supply; Distribution; Pipe; Hydrants; Records; etc.

Sewage Treatment Plants.—Bulletin No. 101, dated February, 1929, has just been received from the Pacific Flush Tank Company, 4241 Ravenswood Avenue, Chicago, or 9 Park Place, New York, describing the Sprinkling Filter Design using the Twin Dosing Tank Equipment. It is a very comprehensive



Every cast iron pipe and casting is thoroughly cleaned before being coated. The illustration below shows the modern method of cleaning a large diameter pipe by use of pneumatic tools.

EFFICIENCY is the keynote of the modern cast iron pipe foundry. Efficiency in foundry planning and operation contributes to a better product. For example, each cupola is operated under strict laboratory control. Further along, but within easy reach of the crane, a runway leads to the cleaning sheds where plant inspectors carefully test each pipe length before passing it on to the dipping vats and testing presses. In other words, after a series of operations similar in principle to the production line of a famous motor car plant, the pipe arrives in flawless condition on the waiting cars.

CAST Q IRON

The "Q-check" symbol shown above has been adopted as the trade mark of The Cast Iron Pipe Research Association. Insist on this "Q-check" mark when specifying cast iron pipe for gas, water, sewer or industrial service.

For complete information write to The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, Peoples Gas Building, Chicago.

The Cast Iron Pipe Research Association is a service organization of leading pipe founders, formed to promote the scientific improvement and proper use of Cast Iron Pipe. Pipe bearing the Association "Q-check" mark may be obtained from the following: American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

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CAST IRON PIPE

presentation of this type of sewage treatment, and contains many detailed illustrations and data concerning large plants in use throughout the country. There are several pages of design data for single and twin tanks with percentage tables. There are also cuts and descriptions of dosing tank counter, nozzles and Marley Tees.

Chlorinizer.—Bulletin No. 20 put out by the Paradon Manufacturing Co., Arlington, N. J., gives full description of Paradon Chlorinizer. Chlorinization is in universal use for sterilization of water supplies, sanitation of swimming pools and for the disinfection of sewage. Operation, advantages, capacity, types of chlorinizers, applicability and specifications are all given in bulletin, and a list of a few typical installations is also included, regarding the Paradon equipment, a chlorinating device for small water supplies, swimming pools, and sewage plants such as in use in small municipalities, factories, camps, estates, country clubs, hotels, etc.

Cast Iron Pipe.—Write to the Central Foundry Company, 420 Lexington Avenue, New York City, for information concerning the cast iron pipe with machined hub and spigot ends, all cast iron, eliminating calking or use of any jointing material. No tool needed but a wrench.

Manhole and Catchbasin Covers.—Wm. E. Dee & Company, 30 North La Salle Street, Chicago, will be pleased to send prices and full particulars concerning their D & D Safety Cover. They guarantee this cover not to rattle or dish.

Diesel Engines.—A bulletin from the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., has been issued describing the diesel power plant at Freeport, L. I., N. Y., where the 6th Busch-Sulzer Diesel—a 1,500 B. hp.—1,050 kw. unit, has just been purchased, making this the largest municipal Diesel plant in the United States, according to statement contained in folder. Their Diesel engines are built in 2-cycle and 4-cycle types, stationary and marine.

Steel Storage Tanks.—Municipal Catalog No. 2 issued by the Pittsburgh-Des Moines Steel Company, 4 Neville Island, Pittsburgh, Pa., give description and information regarding the product of this company for taking care of water consumption during the peak hours and insures a constant pressure at all times. Use of these tanks eliminate fire hazards when repairs are being made at the pumping plant. Information will be furnished concerning complete water works system, pipe lines, reservoirs, filtration, purification, etc.

Fact Book of Steel Construction.—The American Institute of Steel Construction, Inc., 285 Madison Avenue, New York City, has just published a Fact Book which lists the steel fabricators of the United States, Canada, Mexico and Hawaii. It presents in chart and tables the statistics of steel, fabrication and construction work. In addition to presenting data relating to the tallest and largest buildings in the United States it also publishes for the first time the most complete list of steel bridges in the U. S. This book has been brought out because of the now general use of the skyscraper throughout the land and the widespread interest in the fabrication of structural steel.

Porous Concrete Well.—F. Thorpe, 1932 Illinois Avenue, East St. Louis, Ill., will be pleased to send you folder describing this type of well and will furnish a list of references. Some of the outstanding features are length of life, elimination of repair or maintenance costs, satisfied owners, etc.

Toledo Torch.—The new Toledo Torch "Champion" is the product of the Toledo Pressed Steel Co., Toledo, O. Write to the manufacturer for full information as to construction, service and costs.

Steel Sheet Piling.—Address Wemlinger, Inc., Singer Building, New York, or 228 North La Salle Street, Chicago, for information in regard to buying or renting steel sheet piling.

Clay Products.—Wm. E. Dee Clay Mfg. Co., 30 N. La Salle Street, Chicago, manufacturers of standard and double strength sewer pipe, drain tile, culvert pipe, well tubing, flue lining, wall coping and fire brick, will be pleased to send you full information on any or all of these products.

Sewer Flusher.—Petersen's Hydraulic Flusher Company, 277 First Avenue, Milwaukee, Wis., will be pleased to send you literature illustrating and fully describing their sewer and pipe flushers. It is made in three styles of heavy grade canvas and waterproof tubing. A labor saving tool for city, contractors and manufacturers, and an economical way of clearing sewers.

Cast Iron Pipe.—An attractive folder from the McWane Cast Iron Pipe Company of Birmingham, Ala., and Provo, Utah, shows many successful uses for this pipe. It is used in parks for feeding sprinkling systems, by railroads in yards for water, air and low-pressure steam lines, etc., all of the 2-in. size. It is also made in 4, 6, 8, 10 and 12-in. sizes. Manufacturer will be pleased to send literature illustrating and describing pipe in all sizes for all uses.

Pumps.—Bulletin P-29 issued by the Jaeger Machine Company, Columbus, O., gives illustrations, specifications and full description of diaphragm, plunger type, lift and force centrifugals. The Speed Boy is a 4-cycle high speed engine with foot starter coupled with non-clogging big volume pump with Jaeger open type brass impeller that handles 25 per cent to 28 per cent solid matter such as sand, mud or solid stones. Write for this bulletin.

Cast Iron Pipe.—A very attractive booklet called "Small Diameter Cast Iron Pipe" has just been issued bearing the name of the American Cast Iron Pipe Co., Birmingham, Ala. Types of small diameter pipe described in booklet include: Simplex Prepared Joint Cast Iron Pipe; Two-Inch Bell-and-Spigot Cast Iron Pipe; Two-Inch Prepared Joint Cast Iron Pipe; Threaded-End Cast Iron Pipe; Doublex Simplex Cast Iron Pipe; Flanged Cast Iron Pipe; Cast Iron Pipe for Vitaulic Joints; Bronze Welded Joints and Small Diameter Cement Lined Pipe. Booklet is printed on heavy enamel paper and has an extra heavy cover.

Calatom.—An admixture for concrete which is mined, milled and refined exclusively by Monterey Products Company, Monterey, Cal., and distributed east of the Rocky Mountains by Tamms Silica Company. Calatom is a low water absorption diatomaceous earth for workability and waterproof concrete. Write to the Tamms Silica Company, Stock Exchange Building, Chicago, Ill., for literature giving complete information concerning this powered admixture.

Deep Well Water Systems, Etc.—Alamo Engine Company, Hillsdale, Mich., has issued a very attractive 60 page booklet in loose leaf style, describing the use of Alamo-Dorward Rotary Power Head, for operating deep well and other types of reciprocating plunger pumps. Booklet contains cross sectional drawings, explanation of capacity table captions with several pages of capacity tables.

Meter Boxes, Couplings, Testers, Service Boxes, Etc.—Catalog No. 24 issued by H. W. Clark Company, Mattoon, Ill., gives full information in regard to their meter protection boxes, constructed of bronze, with locking device and assuring safeguard from climatic conditions. Construction provides for accessibility for repair work or replacements. Full particulars furnished on all equipment.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Cast Iron Pipe.—"Spi-Cor" is the title of a little booklet issued by the American Casting Company, Birmingham, telling the story of a new era in "culverting." It gives much interesting information in condensed form on spiral corrugated cast iron pipe. If writing for booklet, kindly give the name of our publication.

SAVE YOUR TIME! USE OUR SERVICE! Prices on equipment, names of manufacturers or their catalogs will be cheerfully furnished to you by our Service Department. Write Water Works and Sewerage, 221 E. 20th St., Chicago.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

South American Distributors Visited by American Bosch Executive

Mr. Herbert E. Fenner, General Service Manager of the American Bosch Magneto Corporation at Springfield, Mass., sailed from New York recently to make an extended tour of inspection of all the principal cities, and many smaller centers, in the countries of South America.

One of Mr. Fenner's principal duties will be to call upon the branch houses and distributors of those American manufacturers who use American Bosch precision electrical equipment as standard equipment on automotive products of their manufacturer. He will also visit official American Bosch service stations situated throughout the South American continent to make a first hand study of methods and offer advice and suggestions.

Gardner Denver Takes Larger Quarters in New York

Due to recent increases of business in the New England states, the Gardner-Denver Co. last week moved its New York branch office from 30 Church St. to larger quarters at 147 Varick St. The new quarters afford space for both office and warehousing purposes.

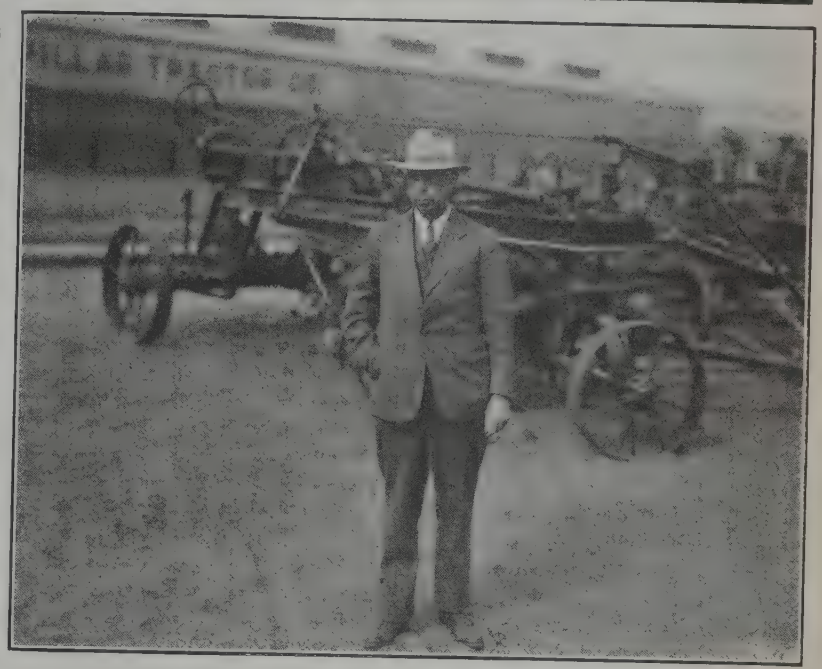
The Gardner-Denver Co., manufactures slush pumps, air compressors, high pressure drill steel forges, rock drills and drill sharpeners. Its plants are located in Denver, Colo.; Quincy, Ill., and LaGrange, Mo.

Chain Belt Opens Boston Office

The Chain Belt Company, Milwaukee, has opened a New England district office in Boston at 950 Park Square Building. This makes the eighteenth district office the company has opened in the United States within a comparatively few years. J. K. Merwin is district manager.

Mr. Merwin is a Yale University graduate of 1924. He worked at the Chain Belt Company's Milwaukee and West Milwaukee plants. Later he went to Cleveland with the company's subsidiary, the Stearns Conveyor Company.

The Boston office will manage the distribution of the company's entire line of Conveying Systems, Power Plant Equipment, Chains and Transmission Machinery.



Mr. Charles A. Spears, Now Representing "Caterpillar"

C. A. Spears Joins "Caterpillar"

C. A. Spears, widely known on the Pacific Coast as an authority on roads and streets, and who has a large acquaintance among contractors and governmental men, has joined the sales engineering staff of the Caterpillar Tractor Company, according to recent announcement. For the past 17 years Mr. Spears has been connected with Spears, Wells Company.

Announcement states that Mr. Spears' time will be devoted to helping solve earth moving problems confronting engineers, contractors and government officials.

Cutler-Hammer Establish St. Louis Warehouse

A warehouse, where a stock of standard C-H motor control and wiring devices will be carried for immediate delivery, has been established by Cutler-Hammer, Inc., at 1914 Washington Ave., St. Louis, Mo. The St. Louis district sales office has been moved from 611 Olive St. to the same address as the warehouse. The new location will give about 4,000 sq. ft. of space for warehouse purposes, and the increased facilities, it is announced by the company, will enable them to better serve their trade in the south and mid-west.

The territory served by the St. Louis office includes the states of Kansas, Missouri, Oklahoma, Arkansas, Louisiana, Texas, southern Illinois, southern New Mexico and parts of Tennessee, Kentucky and Indiana. Headquarters of Cutler-Hammer, Inc., are located in Milwaukee, Wis.

Wagner Electric Announces Branch Office Removals

Wagner Electric Corporation, whose headquarters are located at 6400 Plymouth Ave., St. Louis, announce that the Milwaukee sales office and service station, formerly at 501 Broadway, has been moved to 525-27 Broadway. The St. Louis sales office has been removed from 505 Sheel Building to 909 Plaza Olive Building.

According to announcement, the changes were necessitated by increased business requiring more space.

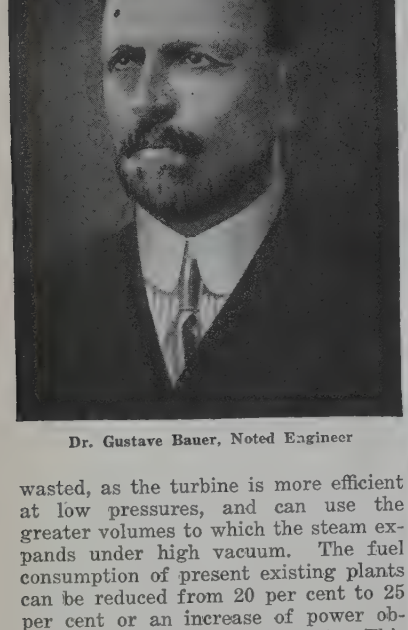
Change of Address

The Wallace Equipment Company of Detroit, Mich., announces that they are now occupying their new office, shop and warehouse located at 8511 Livernois Ave. The officials of this company are Mr. Geo. T. Wallace and Mr. John Cavan.

Bauer-Wach System Under License to DeLaval

The De Laval Steam Turbine Company of Trenton, N. J., builders of geared steam turbines for numerous well-known vessels of the American Merchant and Naval Marine, has taken a license to manufacture under the American Bauer-Wach patents.

These patents cover the use of exhaust turbines and gears to utilize the exhaust from reciprocating engines, thereby developing and transferring to the same shaft 20 per cent to 25 per cent more power from heat otherwise



Dr. Gustave Bauer, Noted Engineer

wasted, as the turbine is more efficient at low pressures, and can use the greater volumes to which the steam expands under high vacuum. The fuel consumption of present existing plants can be reduced from 20 per cent to 25 per cent or an increase of power obtained as high as 25 per cent. This system also has the advantage that the turbine alone can propel the vessel at 60 per cent of full speed if the engine becomes disabled.

While the first installation of the Bauer-Wach System was made less than three years ago, it is said to have been successfully applied up to the present time in over 135 vessels with a total horsepower of over 500,000. Dr. Gustav Bauer, whose name it bears, is the engineer responsible for the machinery of the North German Lloyd steamer "Bremen," holder of Atlantic records for speed.

Eastern Manufacturer Returns from Southwestern Trip

Mr. Earle S. Philips, vice-president of the Good Roads Machinery Company of Kennett Square, Pa., has recently returned from an extended business trip into the southwest section of the country, his objctive being San Antonio, Texas. Mr. Philips reports conditions very good indeed in the southwest, and he is anticipating a good fall and winter business from that section.

During the trip Mr. Philips visited the Muskogee Iron Works Company of Muskogee, Okla.; J. B. Harbison Equipment Company of Little Rock, Ark., and C. P. Hollingsworth, San Antonio, Texas.

H. H. Curtice Heads AC Spark Plug Company

At a recent meeting of the Board of Directors of the AC Spark Plug Company of Flint, Mich., Harlow H. Curtice was elected president and general manager to succeed Basil W. deGuichard, whose resignation was due to ill health.

Just past his twentieth birthday and fresh from Ferris Institute, where he completed a commercial course, back in 1914, Mr. Curtice obtained his first position in the accounting department of the company to which he has now been elected president. His initiative in instituting improvements resulted in his becoming comptroller when he was twenty-one years old, making him, it is said, the youngest executive in the automotive industry.

In 1923 he was made assistant general manager, in which position he gained prominence in factory operations and management work. In 1927 he was given the title of vice-president. Through his management of the affairs of the AC plant, he not only came in contact with every department of his own company, but came in touch with practically all manufacturers in the automotive, aviation and marine industries.

Mr. Curtice's election to the presidency of his company at the age of 36 years places him in the position of one of the youngest major chief executives in the automotive industry. He was born at Eaton Rapids, August 15, 1893, and graduated from the high school before entering Ferris Institute.

Gurley Sales Office Announces Removal

W. & L. E. Gurley, manufacturers of surveying instruments and hydraulic measuring equipment, announces the removal of their New York sales office from 25 Warren St. to 1202 Emigrant Industrial Savings Bank Building, 49 Chambers St.

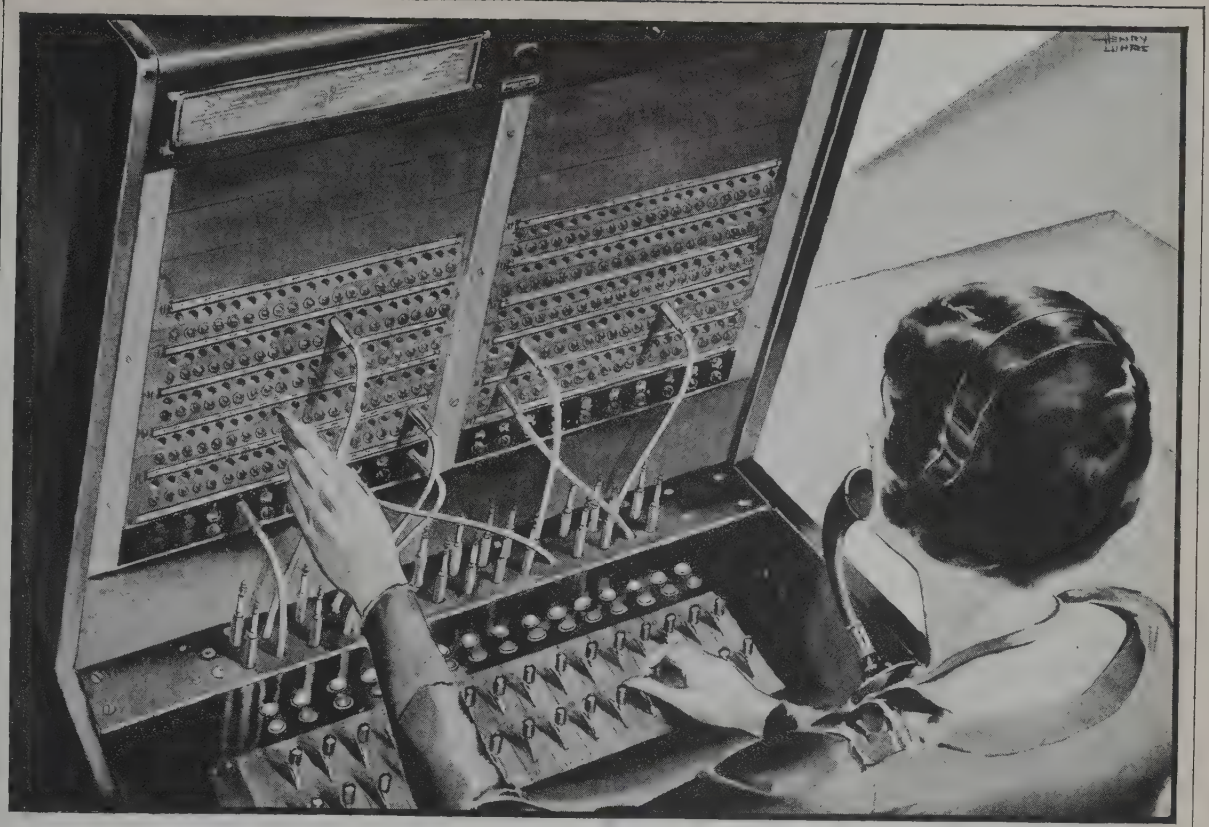
The company believes they have been very fortunate in their new location, as the office overlooks City Hall Park, commanding a splendid view, and offers an unusual opportunity for the comparison of telescopes.

Mr. C. C. Covert, hydraulic engineer, is in charge of the display of instruments.

Foreign Industrialists Visit American Plants

A group of representatives of prominent German industrial concerns while on a tour of observation, visiting automotive plants, studying American manufacturing methods, and devoting much attention to highway construction and fuel problems. Picture taken at Flint, Mich., during visit at AC Spark Plug plant, a division of the General Motors Corporation.

Left to right: E. F. Kress, engineer with American branch of I. G. Dye Trust; T. G. McDougal, AC vice-president in charge of foreign plants; Richard Baacke, director of I. G. Dye Trust; W. Ranft, German Gasoline Company; Dr. Martin Muller-Cunradi, I. G. Dye Trust; Wa. Ostwald, editor of the Automobil-Technische Zeitschrift; Dr. Hans Navratiel, petrologist, AC Spark Plug Company.



THE FAR-FLUNG PARTS OF AN ORGANIZATION, ITS DEALERS AND ITS CUSTOMERS, ARE BROUGHT AS CLOSE AS INSTANT SPEECH

Great strides in invention, great expenditures . . .

An Advertisement of the
American Telephone and Telegraph Company

BUSINESS, using the telephone, eliminates space and time. The far-flung parts of an organization with its dealers and customers are brought together by instant speech. The home, like the office, reaches out over an ever-widening circle of neighbors.

The telephone is tireless and quick. It runs errands near and far, transacts business, keeps friendships alive. Telephones throughout the house save time and fatigue. They bring the comforts and conveniences of the office to the women in the home.

Keeping ahead of the new developments in American life calls for great strides in inventions, great expenditures in money.

The Bell System's outlay this year for new plant and service improvements is more than 550 million dollars. This is one and one-half times the cost of the Panama Canal.

This program is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addesses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for northern California terirtory. Now stocking equipment for several well known machinery manufacturers.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two-cycle oil and gas engines, in sizes from 30 to 125 hp., adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Attractive territory available for experienced men to handle contractors' labor-saving equipment by old established company. Equipment backed by national advertising.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

Manufacturer has some attractive territory available for distributors of complete line of generators, centrifugal, diaphragm and piston pumps.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the southwest and middlewest.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

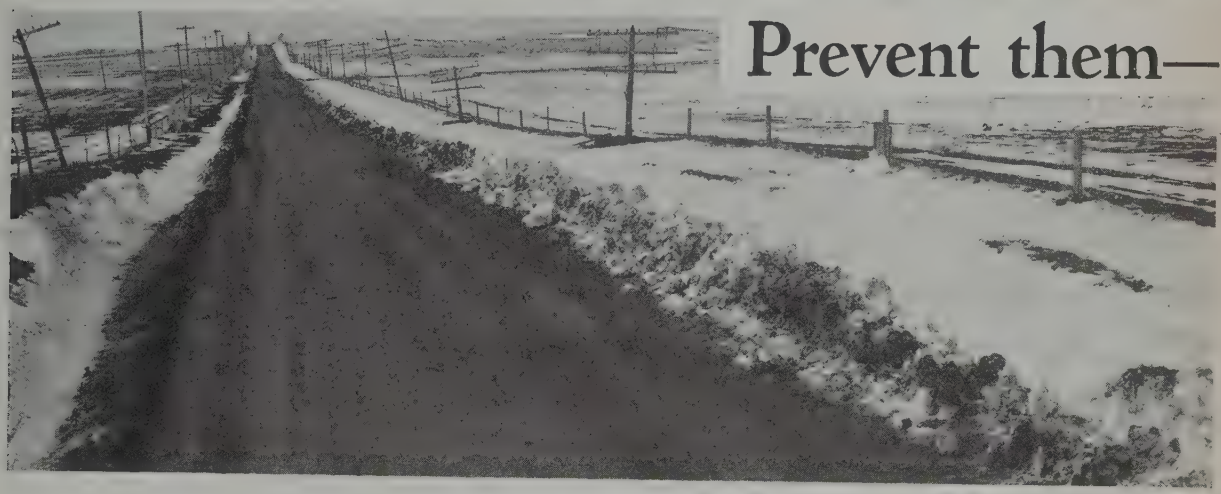
Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of rotary pump, especially designed for road construction work, has proposition for reliable distribution houses.

Good side-line offered to manufacturers' representatives covering municipalities and public institutions.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

Ruts ruin roads



Prevent them—

with full-width snow-removal

Prices—f. o. b. Peoria, Illinois

TEN . . .	$1125	TWENTY .	$1975
FIFTEEN .	$1500	THIRTY .	$2475
SIXTY . .	$4300		

Caterpillar Tractor Co.

PEORIA, ILLINOIS *and*
SAN LEANDRO, CALIF., U. S. A.
Track-type Tractors Combines Road Machinery
(There is a "Caterpillar" Dealer Near You)

"Caterpillar" Tractors furnish surging power and sure traction for the job.

CATERPILLAR
REG U.S. PAT OFF.
TRACTOR

Byers Machine Co. Appoints Michigan Distributor

The Byers Machine Co., Ravenna, O., announce that the W. H. Anderson Tool and Supply Co. of Detroit, Mich., has been appointed as their Michigan distributor.

This well known contractors' equipment dealer will handle the complete line of Byers excavating and material handling tools, which includes 1¼ yd., 1 yd., ¾ yd. and ½ yd. gas power shovels and cranes.

The W. H. Anderson Tool and Supply Co. has established a reputation for handling dependable products for several nationally known manufacturers, some of which they have represented continuously for 14, 15 and 16 years. Contractors in the state of Michigan can now procure all literature and information relative to Byers shovels from this company.

Ford Museum Secures Old Engine

An old C. & G. Cooper & Co. portable, single cylinder steam engine has been acquired by Henry Ford for his museum at Dearborn, Michigan. In repairing the engine for exhibition purposes the Ford engineers found that the governor was missing but on the valve chamber, still in place was stamped "1½, R. W. Gardner, Patented August 14, 1874."

Inquiry developed that the "R. W. Gardner" of 1874 is the present Gardner-Denver Company of Quincy, Illinois. The Ford Company wrote this organization explaining the situation and adding:

"It is our aim to reconstruct this engine, using all the old parts possible. Could you supply an exact duplicate of governor and valve, using the information and sketch inclosed as reference?"

J. W. Gardner, president of the Gardner-Denver Company and son of the founder of the concern, is having the parts made for Mr. Ford.

Bulk Cement to Be Shipped Via Chesapeake Waters

The first all-steel, self-unloading barge for transporting bulk cement in Chesapeake waters was launched recently at the plant of the New York Shipbuilding Company at Camden, N. J., according to announcement of the Lone Star Cement Company Virginia, Inc. It is to be used to carry bulk cement from the company's South Norfolk mill to Washington, D. C., warehouse. The barge was christened "Lone Star No. 1" by Mrs. Dwight Morgan, wife of the vice-president and manager of the Lone Star Cement Company Virginia.

The barge is 163 ft. in length and has a beam of 37 ft. 4 in., with total capacity of 5,600 barrels of cement.

In explaining the purpose of the new barge, Mr. Morgan said that by providing the most economical means of transportation for a rapidly growing market, an outlet is being established for the product of Norfolk labor, which means an additional source of income to find its way into Norfolk business enterprises.

Mr. Morgan also stated that by the use of the low-cost transportation of the natural waterways of the country, added strength is given to the effort to combat foreign cement produced under the low wage scale and transportation costs of foreign manufacturers.

St. Clair of Hercules Goes to Wilmington

J. R. St. Clair, formerly of the sales force of the Hercules Powder Company's branch office in Duluth, Minn., will join Hercules' explosive technical service staff in Wilmington, Del., November 15th. Mr. St. Clair has had wide experience in mines and quarries of the Duluth district.

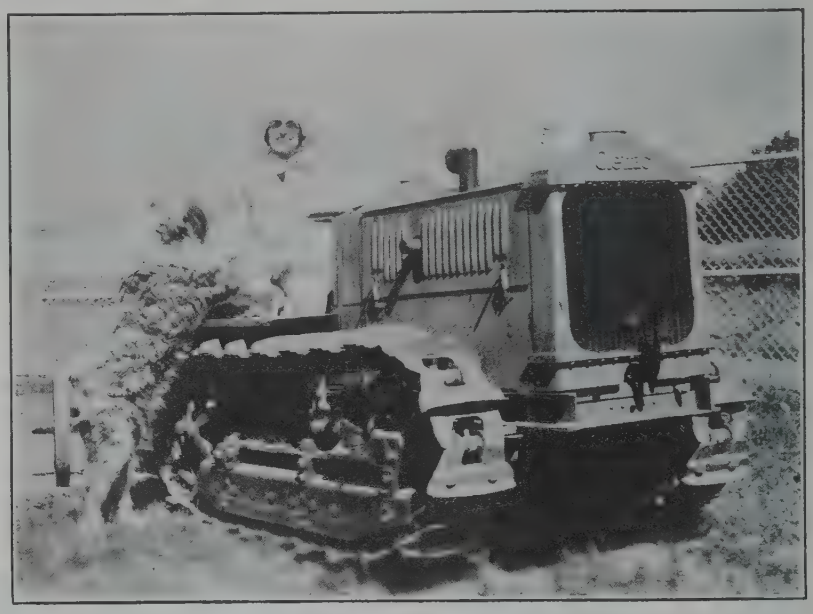
Chicago Pump Company announces the addition of Chas. P. Hery to their list of representatives.

Mr. Hery will control the Rochester, N. Y., territory, with offices in the Cutler Bldg.

Pennsylvania Pump and Compressor Company of Easton, Pa., announces the appointment of Mr. Joseph W. Eshelman as representative in the Birmingham, Alabama district. Mr. Eshelman's Birmingham address is American Traders Bank Building.

Galli-Curci Sings Tractor Praises

Galli-Curci, the noted singer owns and uses a Cleveland Tractor on her estate "Sul Monte" near Highmount, New York. The letter which she wrote to the local dealer concerning the tractor is one of the greatly prized possessions of the manufacturer. So proud are they of this letter and picture of the great singer that they have passed it around.



The Lady and the Tractor

"I have no objection at all to let The Cleveland Tractor Company use my picture for publicity purposes, inasmuch as I am a sincere admirer of the tractor.

I send my very best wishes.

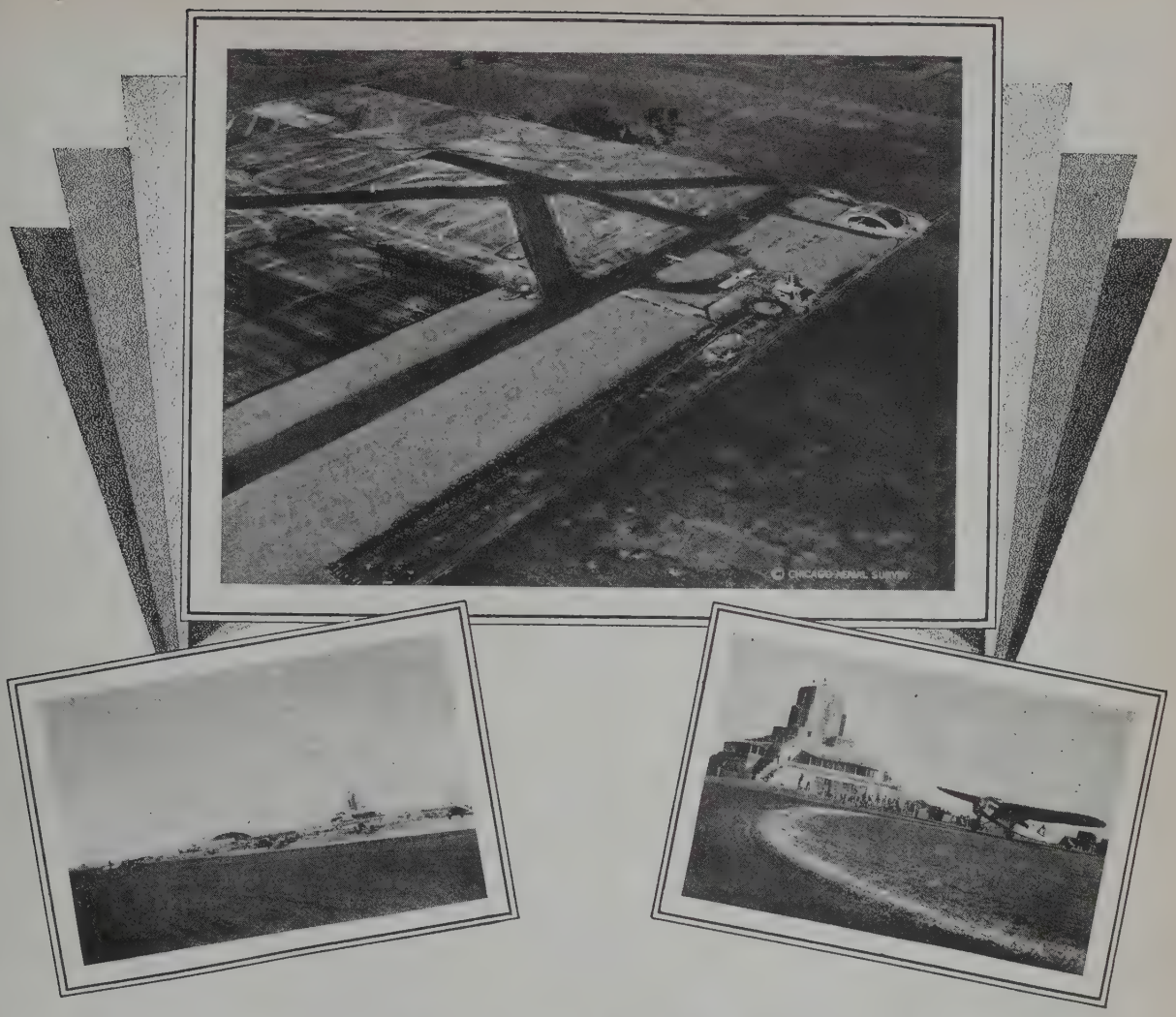
Sincerely yours,
AMELITA GALLI-CURCI."

Kelleher of Hercules Transferred to Delaware

J. J. Kelleher, well known throughout the southeast as an experienced explosives man, leaves Tampa, Fla., to make Wilmington, Del., Hercules' home office, his headquarters.

Mr. Kelleher is to be associated with the contractors' division, explosives department of the Hercules Powder Company.

Trackson Company, of Milwaukee Wisconsin, announces the appointment of the L. A. Snow Company as distributors for the Trackson and McCormick-Deering lines of tractor and tractor equipment. The new distribution agency is located at 134 International Right of Way, Spokane, Washington and will cover the Spokane territory. Mr. Don E. Lillie is manager for the Snow Company and is prepared to give prompt service on all orders.



Standard Asphalt Road Oil

at

SKY HARBOR AIRPORT

These views of Sky Harbor Airport, at Chicago, Illinois, show runways constructed with cinders and Standard Asphalt Road Oil.

The construction method was as follows: No. 5 Road Oil was applied to the top six inch layer of well graded cinders at the rate of 1½ gallons per square yard in three applications. After each application, the Road Oil and cinders were thoroughly mixed and brought to a surface by the mixed-in-place method. A smooth surface and compression were obtained by rolling.

Numerous nationally known pilots have stated that Sky Harbor has the best paved runways and landing field in the country.

STANDARD OIL COMPANY (*Indiana*)

General Offices: **910 South Michigan Ave.** **Chicago, Illinois**

Chicago	Detroit	Grand Rapids	Joliet	Mason City	Saginaw	South Bend
Davenport	Duluth	Green Bay	Kansas City	Milwaukee	Sioux City	St. Louis
Decatur	Evansville	Huron	La Crosse	Minneapolis	Peoria	St. Joseph
Des Moines	Fargo	Indianapolis	Mankato	Minot	Quincy	Wichita

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USEFUL EQUIPMENT INFORMATION

Water Plants.—"Municipal Water Works" is the title of a booklet recently issued by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. In addition to building storage tanks, this company is equipped to execute contracts for complete water works systems. The booklet describes various installations. Several useful tables are included.

Cement-Lined Pipe.—The Cement-Lined Pipe Co., Lynn, Mass., will be pleased to send "Cement-Lined Pipe for Corrosive Waters," a thorough discussion of the uses and advantages of water pipe lined with cement. Tables of weights and comparative costs are included.

Meters and Accessories.—The Pittsburg Equitable Meter Co., Pittsburgh, Pa., will be glad to send illustrated booklets covering meters, testing apparatus and various accessories for the meter department. The booklets contain drawings, specifications and tables of dimensions.

Refuse Disposal.—A valuable book for all who are concerned with the problem of refuse disposal is "Disposal of Municipal Refuse by Incineration." Whoever is planning or operating a disposal plant, municipal or private, should have this book. A copy may be secured from the Morse Boulger Destructor Co., 205 E. 42d St., New York, N. Y.

Moore Speedcrane.—The latest catalog of the Manitowoc Engineering Works, Manitowoc, Wis., describing the Moore "Speedcrane" shovel, dragline and trenchoe, presents a number of advanced features incorporated in this equipment. A copy may be secured by writing to the manufacturers.

Baker Bulldozers.—Bulletin No. 273 of the Baker Mfg. Co., Springfield, Ill., presents Baker hydraulic bulldozers for Caterpillar "30" and "60" tractors. A copy will be sent upon application.

Samplers and Mixers.—"Samplitt," a device by which samples of liquid are automatically secured from pipe lines as the liquid passes through the line, and "Mixitt," a device by which a small amount of one liquid is automatically injected into another in predetermined and adjustable percentages as the liquid requiring treatment flows through a pipe line, are described in bulletins issued by the Max B. Miller & Co., Inc., New York, N. Y. Tables for choosing sizes of these devices for various uses and conditions are included.

Rensselaer Valves.—The Rensselaer Valve Co., Troy, N. Y., will be pleased to send booklets and folders describing Rensselaer valves, tapping sleeves, crosses, repair sleeves, etc.

By writing the manufacturers named and mentioning this magazine, copies of the catalogs listed below will be sent you without obligation.

Copper Pipe Coupling.—A convenient booklet describing Anderson couplings for copper service pipe is issued by the Chapman Valve Mfg. Co., Indian Orchard, Mass. Specifications for copper service tubes are included.

Boilers.—The Erie City Iron Works, Erie, Pa., has recently issued two booklets, one of 16 pages covering the Erie City 3-drum boiler and one of 12 pages describing and illustrating the "Economic" boiler. A feature of the "Economic" booklet is a large phantom view with the principal points of construction indicated by arrows.

Diesel Engine Catalog.—An attractive 24-page catalog describing their new vertical diesel engine has been issued by the Buckeye Machine Co., of Lima, O. Copies are available to anyone interested.

Valves and Fittings.—The new Reading-Pratt & Cady catalog, No. 300, covers Pratt & Cady iron and bronze valves and asbestos-packed cocks, and Reading cast-steel valves and fittings. It includes much valuable information for the engineer, steamfitter and plumber. The catalog will be found a handy reference book for engineers, purchasing agents and anyone else interested in piping systems and valves and fittings. Copies may be secured by writing to the Reading Steel Casting Co., Inc., Bridgeport, Conn.

High-Temperature Cement.—"Firebond," a high-temperature cement, is described in a booklet recently issued by the Harbison-Walker Refractories Co., Pittsburgh, Pa. This booklet contains some new and useful tables for calculating the quantities of brick required for arches of different spans and thicknesses. These tables should be of interest to anyone connected with firebrick construction. The manufacturers will be pleased to send a copy to those interested.

Water Works Tools and Supplies.—Valves, hydrants, valve inserting machines, tapping machines, pipe cutters and other water works tools and supplies are described in a catalog of the A. P. Smith Mfg. Co., East Orange, N. J. Every water works superintendent should have a copy of this catalog.

For Recording Bids.—A convenience for contractors and officials alike is a bid record book, published by the United States Cast-Iron Pipe & Foundry Co., Burlington, N. J. It contains a table of standard thicknesses and weights of cast-iron pipe.

Federal Meters.—The latest Federal meters are presented in a bulletin of the Federal Meter Corp., East Orange, N. J. A copy will be sent upon application.

Incinerators.—A useful discussion of incineration, an account of the design and manufacture of "United States Standard" incinerators and a series of brief descriptions of installations of these incinerators are contained in a booklet issued by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. Personal service in the matter of choice of a system of municipal refuse disposal is offered city officials by the Pittsburgh-Des Moines organization.

Venturi Meters.—Two booklets, "The Venturi Meter for Main Pipe Lines" and "Filtration Plant Equipment," have been issued by the Builders Iron Foundry, Providence, R. I. Valuable data for plant designers and all who are concerned with the measurement of flow in large pipe lines are contained within these bulletins. The type KS shunt meter, also manufactured by this foundry, is described in a leaflet which gives useful capacity tables.

Forced-Draft Fans.—The use of low grade, cheap fuels has been made possible in the last few years by the adoption of small forced-draft fans and special grates on domestic and other small furnaces and boilers. The American Blower Corp. has published a catalog showing standard forced-draft fans suitable for this use. The catalog also gives application and technical data of interest to any who contemplate installations of this kind. It is claimed that the use of the cheaper grades of fuel will pay for the necessary equipment in a very short time without loss of heating efficiency in the furnace. It is also claimed that the use of the forced-draft blower gives quicker "heating up" capacity and more flexible operation. The American Blower Corp., Detroit, Mich., will be glad to send a copy of their bulletin No. 10401 on this subject upon request.

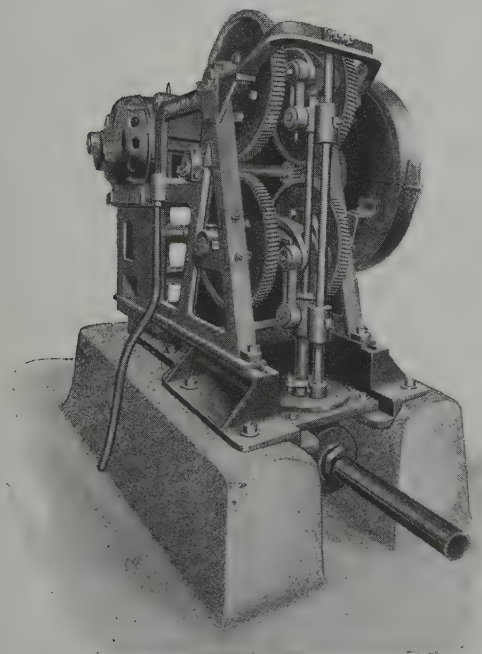
Synchronous Motor Generators.—The Westinghouse Electric & Manufacturing Co. announces in leaflet 3746-B its new line of fabricated synchronous motor-generator sets. The application, distinctive features and details of construction of these sets are fully described, and the illustrations include

THE "POMONA"
DOUBLE STROKE DEEPWELL
POWER PUMP
IS THE
IDEAL PUMP
FOR USE WHERE
PUMPING CONDITIONS
ARE SEVERE
AND
WATER SUPPLY
MUST BE
ASSURED!

Interesting Pumping Information Gladly Furnished. Write for it Today

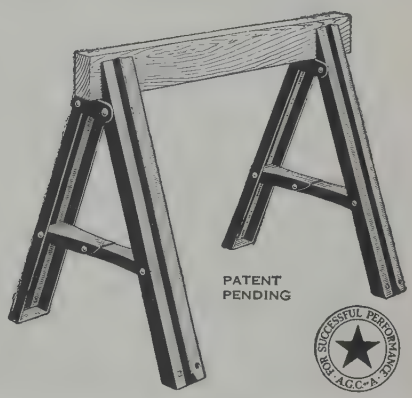
UNITED
IRON WORKS, Inc.
SPRINGFIELD, MO.

"UNITED" IRON WORKS INC. REG. U.S. PAT. OFF. FOR SERVICE



Can You Beat This?

The entire barricade shown in this picture was built complete, by one man, in less than two minutes. He was wise. He used TOLEDO HORSES.



The TOLEDO HORSE

which saves thousands of hours time every day in nearly all branches of industry, is especially handy in building highway barricades, being simple to operate yet absolutely rigid.

You need no special material. Any handy piece of lumber will do for the rail. If it isn't the right length you can splice it between the jaws without nailing.

TOLEDO HORSES are fully collapsible and a great many of them can be carried or stored in very small space. They are made of steel and are indestructible.

Let us send you further particulars at once, or see them at your dealer's.

THE
Toledo Pressed Steel Co.
TOLEDO :: OHIO

photographs of the sets complete and various details in construction. The ratings of the standard sizes of these motor generator sets, 2-unit and 3-unit, for 60, 25 and 50-cycle service, are given.

Alternating Current Generators.—Leaflet 20355-A has been issued by the Westinghouse Electric & Manufacturing Co., covering type ES engine-driven alternating-current synchronous generators. This is a revised edition of the leaflet describing fully the new fabricated construction for these type ES generators. These generators are designed for direct connection to steam, gas or oil engines and are built completely of structural steel, fabricated with the electric arc. The leaflet is illustrated with installation views and detail photographs.

Fighting Fire.—"Modern Fire Fighting Equipment," the latest catalog published by the American-LaFrance & Foamite Corp., of Elmira, N. Y., is now ready for distribution.

The catalog, which contains complete listings and descriptions of practically every imaginable kind of portable fire fighting equipment, is 176 pages in length. The eight sections of the book are listed under the following titles: fire station equipment, fire apparatus and equipment, fire hose and accessories, fire signaling equipment, chemical fire fighting equipment, firemen's clothing and equipment, hose carrying equipment and safety first equipment.

Centrifugal Compressors and Blowers.—A new catalog on centrifugal compressors and blowers just issued by the De Laval Steam Turbine Co., Trenton, N. J., illustrates the remarkable progress being made by centrifugal machinery in many fields. Turbine-driven blast furnace blowers rated at 60,000 cu. ft. per minute against 30 lb. maximum pressure at 2,800 r.p.m. are shown. Both single and multi-stage blowers and boosters are shown for use in water-gas plants, and in connection with coal-gas retorts and coke ovens. Higher gas pressures are becoming general in the gas industry for the transmission of large quantities of gas through existing mains or to reduce the first cost of mains for long-distance distribution. For this work large multi-stage compressors are used, driven by steam turbines or variable speed motors, the latter being connected to the compressor, in some instances, by speed increasers. Centrifugal blowers and compressors are also applied to blowing Bessemer converters, supplying air to oil and gas-fired furnaces, blowing cupolas, agitation of liquids, as in the activated sludge method of sewage purification and in flotation methods of ore separation, for the pneumatic handling of materials, super-charging diesel engines, etc. The De Laval book closes with a concise presentation of the mechanics and thermodynamics of the compression of gases and the physical properties of industrial gases, with numerous illustrative examples worked out in detail.

Sewage Chlorination.—Wallace & Tiernan Co., Inc., Newark, N. J., has just mailed to all sanitary engineers, sewage plant operators and public health officials in the United States and Canada, a reprint of the article "Advancements and Developments in Sewage Chlorination" by Linn H. Enslow, research engineer of the Chlorine Institute. The article is published in the standard 6x9-in. size used by Wallace & Tiernan for this type of educational publicity. It should be of value to all who are interested in sewage chlorination.

Trailers.—Highway Trailer Co. has recently issued a pamphlet illustrating the many ways in which their trailers serve the public utilities. Contractors in any field will receive many profitable suggestions from this release, which the manufacturers will be pleased to supply.

Knickerbocker Mixers.—Catalog No. 29 presents the complete line of Knickerbocker concrete, mortar, plaster and mastic mixers. A feature of the concrete mixers is the new Knickerbocker device for securing accurate control of the water introduced into the mix. Dimensioned drawings and detailed specifications of the mixers are included. This catalog also describes Knickerbocker saw rigs. Write to the Knickerbocker Co., Jackson, Mich.

High-Early-Strength Cement. — Examples of the saving of time on paving jobs by the use of "Incor" high-early-strength portland cement are cited in a folder recently issued by the International Cement Corp., 342 Madison Ave., New York, N. Y. This corporation is composed of 11 cement companies in the United States, Cuba, and South America, which have a combined output of 20,000,000 barrels of cement annually. Contractors and officials who are interested in minimizing delays caused by construction should write for this bulletin.

Marquette Cement.—"Marquette Super Cement Concrete" is the title of a 24-page booklet recently issued by the Marquette Cement Manufacturing Co., Chicago, Ill. Various jobs in which Marquette cement has been used are illustrated. There is included a brief manual of recommended construction practice, covering the structural use of this manufacturer's product. Write for a copy.

Street and Parking Signs.—A folder from the A. D. Joslin Manufacturing Co., Manistee, Mich., describes the Joslin line of weatherproof street signs. Standard street markers and parking and zone signs are illustrated. Joslin street signs are guaranteed to be readable for 10 years. The makers will be glad to provide you with a folder.

Motor Sweepers.—The Austin motor pick-up sweeper is described in Catalog No. 8, issued by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill. This is a sprinkler-sweeper with oscillating gutter broom and rear pick-up broom. The catalog contains specifications and detailed drawings, photographs and cross-sections of the sweeper. The manufacturers will be pleased to furnish you with a copy.

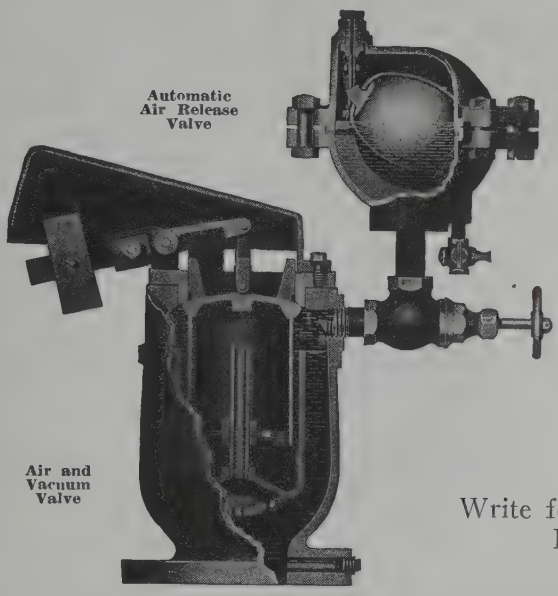
Street Signals. — Write to the Rochester Street Signal Co., 400 Ward Building, Rochester, N. Y., for a folder describing "Monroe" and "Simplex" street signs. The "Monroe" unit is the only one in the market that employs no screws, nuts or bolts in the assembling. The fittings are made of aluminum. The sign plates are enameled. Inquiries are invited.

Wallace & Tiernan.—We have had the pleasure of receiving the latest Wallace & Tiernan bulletins, by title "Vacuum 'Type MSV' Chlorinator," "The Sanitation of Swimming Pools," "Chlorine in Sewage Purification," "Chlorination of Small Water Supplies" and "Wallace & Tiernan Highway Flashers." The use of chlorine in the disinfection of sewage is increasing, and a perusal of the Wallace & Tiernan bulletin dealing with this application of their products is recommended to all engineers and officials dealing with the and a perusal of the Wallace & Tiernan highway flashers are dry battery operated. The booklet includes specifications, drawings and typical layouts. A traffic engineer in the employ of the company is at the service of all municipalities having traffic problems. The Wallace & Tiernan publications are attractive typographically, delighting the eye at the same time as the mind is instructed by the subject-matter. Wallace & Tiernan Co., Inc., Newark, N. J., will be glad to send you copies.

Vertical Gas Engines.—Bulletin 782 of the Chicago Pneumatic Tool Co. describes the type RHG 75 vertical gas engines manufactured by this company. This is really a diesel engine adapted to the use of gas as a fuel. The booklet contains dimensioned drawings and photographs. The manufacturers will be glad to send you a copy. This company maintains an engineering department placed at the service of the customer to assist in solving difficulties and to make recommendations. Service branches are widely distributed and skilled service men are quickly available.

Bilge Pumps.—Bulletin B-3400 of the Yeomans Brothers Co., 1433 Dayton St., Chicago, presents the Yeomans line of heavy-duty bilge pumps. These pumps are built in single and duplex types and can be furnished with regular equipment or with a number of special features such as slow-speed motors, high water alarms, pipe casings for floats, automatic oil economizers, etc., which increase still further the reliability and durability of the machines. Drawings and data tables are included. Write to the manufacturer for a copy.

AIR IN PIPE LINES—



SIMPLEX VALVES

SIMPLEX AIR AND VACUUM VALVES instantly and automatically open the main to the atmosphere. SIMPLEX AUTOMATIC AIR RELEASE VALVES release accumulations of air at pipe line summits.

Valves may be furnished separately or combined as shown

Write for Bulletin 40 "Air Valves for Pipe Lines"
It is a new bulletin just off the press.

SIMPLEX VALVE & METER CO.
6749 Upland Street Philadelphia, Pa.

CAREY Elastite Expansion Joint keeps its shape. Will not melt—will not become brittle; is not affected by moisture or frost. Common labor can install it easily. No loss, no waste, no breakage, in storage or in handling.

The Philip Carey Company
Lockland, Cincinnati, Ohio

Carey Elastite EXPANSION JOINT
TRADE MARK REG'D U.S. PAT. OFF.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

Servicised Products.—Catalog No. 12 of the Servicised Products Corp. has just come from the printer. This book deals with expansion joints in a rather brief but fairly complete manner, and treats exhaustively of other Servicised products of later development. Most important of these are fibrated asphalt planking, industrial flooring, rail filler, highway crossings and protection course for waterproofing. Readers interested in any way in waterproofing protection materials for use in connection with concrete construction for any purpose will find much that is interesting in the new Servicised catalog. Servicised expansion joints are treated completely in Servicised catalog No. 11, which is also available.

Water Wheels.—Bulletin W203 of the James Leffel & Co. is the first of a series being prepared on typical Leffel water wheel installations. This bulletin features the open penstock installation with submerged type gate operating mechanism. Inasmuch as the details in most water wheel installations are entirely covered by concrete or water, or both, the illustrations shown in this and succeeding bulletins will be of particular interest to users of water wheels. Write to the James Leffel Co., Springfield, Ohio, for a copy.

Rotary Positive Blowers.—The P. H. & F. M. Roots Co., of Connersville, Ind., has just issued a new 16-page bulletin, No. 22-B1, on low-pressure type rotary positive blowers. The bulletin covers the new Roots modernized blowers, equipped with Timken, SKF or Hyatt bearings. The bulletin includes a dimensioned print, a table of sizes giving speeds, capacities and horsepowers at various pressures and a brief review of various types of pumping units. Bulletin 22-B1 replaces the former bulletin 1011 issued by this company, and is so constructed as to make it a valuable addition to the large Roots catalog covering pumps, meters and blowers. Write to the manufacturers for a copy.

Centrifugal Pumps.—The waterworks system of the city of Toronto, Ont., which is now being extended by a $14,000,000 addition, is briefly described—with especial reference to the pumping equipment—in a leaflet distributed by the De Laval Steam Turbine Co., Trenton, N. J. Altogether there are 14 large De Laval centrifugal pumps in the several pumping stations, six being driven by geared steam turbines and the others by electric motors using Niagara power. Their aggregate daily capacity is approximately 325,000,000 Imp. gal., representing about 12,000 water hp. A number of these pumps have, on the acceptance tests, made new records for high efficiency.

Chlorinators.—The Pardon Manufacturing Co., Arlington, N. J., has issued Technical Bulletin No. 21, describing the Paradon dry-feed chlorinators, suitable for all purposes of chlorination.

Small-Turbine Leaflet.—"Westinghouse Geared Turbine-Generator Units" is the title of a recent release of the Westinghouse Electric and Manufacturing Co. The pamphlet, No. 20378, includes material on the general features and construction of the new 25 to 50-kw. d-c. geared turbine-generator sets. Photos and drawings show assembly, parts and special devices of the new units. The available ratings with dimensions are also included.

Rust Preventive.—Write to the Chipman Chemical Engineering Co., Inc., 136 Liberty St., New York, N. Y., for booklets describing Atlas marine products. Atlas "Ruskilla" is a quick drying iron and steel paint which contains positive rust-destroying chemicals. It has the ability to stop rust action beneath it.

Pumicite.—Pumicite, an additive to the materials of ordinary concrete, producing a denser, more workable mix, is discussed in a booklet issued by the Pumicite Co., St. Louis, Mo. Every concrete user should be acquainted with the facts cited in this booklet. Write for a copy.

Pipe Fittings Circular.—The Westinghouse Electric and Manufacturing Co. is distributing circular 1676-B on fittings for pipe structures. This is a complete revision of the old leaflet, and includes many new applications for these pipe fittings such as racks in industrial establishments, railings, display racks and pipes of all kinds. The booklet is well illustrated with photographs and drawings.

Lock-Joint Pipe.—The Lock Joint Pipe Co., of Ampere, N. J., has recently issued a bulletin describing installations of their product for water-supply lines in Providence, R. I., and Birmingham, Ala. The pamphlet is well illustrated with photographs and there are some detail drawings. Copies may be secured upon request.

Diesel Engines.—Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., have recently released a series of pamphlets, in which are set forth the experiences of four municipalities with diesel plant operation. The cities contributing to this series are Bryan, Tex., Duncan, Okla., Estherville, Iowa, and Opelousas, La. The pamphlets are illustrated, and plant operating records are included. Every official who is concerned with the power needs of a municipality would do well to avail himself of this information. The manufacturers will be glad to supply it.

"Quikard" Cement.—"Quikard" for speed in concrete construction is the theme of a recent bulletin issued by the Ash Grove Lime & Portland Cement Co., of Kansas City, Mo. This bulletin presents results of laboratory tests and is replete with instances in which concrete employing this high-early-strength cement was carrying its full load within from 24 to 48 hours. Specifications are included. Copies are available for distribution.

One-Bag Mixer.—A folder from the Construction Machinery Co., Waterloo, Iowa, presents the improved Marsh-Capron "Master" 7-S mixer. The manufacturer describes this mixer as "the last word in mixer construction, performance and speed." There are specifications and drawings. Copies of the folder are available.

Crane, Shovel and Dragline.—Catalog No. 629 of the Byers Machine Co., Ravenna, Ohio, announces a ¾-yd. crane, shovel and dragline. This machine is new in model but old in design, the same design being carried through all models from the ½-yd. "Bull Dog" model to the 1¼-yd. "Master." The Byers independent cable crowd and 36 other features are described. Tables and diagrams giving ranges, clearances and capacities are included. The catalog will be sent upon request.

General Electric Products.—We are in receipt of a sheaf of General Electric bulletin, of general interest to designing engineers and contractors in all fields. The titles are as follows:

Centrifugal Air Compressors for Sewage-Disposal Systems.
Reciprocating Air-Compressor Sets, Single-Stage, Stationary.
Reciprocating Air-Compressor Sets, Two-Stage, Stationary.
Reciprocating Air-Compressor Sets, Single-Stage, Portable.
Two-Stage Reciprocating Air Compressors, Types CP-, CPQ- and CPT-26, Suitable for Railway and Industrial Service.
General Electric Type WD-200A Arc Welder, Continental Gas-Engine-Driven.
Travel Carriage for Automatic Air Welders.
Gearless Traction Elevator Motors with Variable-Voltage Control.
G-E Helicoil Sheath-Wire Immersion Heaters.

The General Electric Co., Schenectady, N. Y., will supply copies of these bulletins upon application.

Smith Mixers.—Smith Catalog No. 129, describing the new Smith 14-S non-tilting mixer, is now ready for distribution. Smith water control, improved skip, non-tilting drum, etc., are described in detail. Specifications and dimensioned drawings are included. Write to the T. L. Smith Co., Milwaukee. Wis., for a copy.

Engines.—The Weber Engine Co., Kansas City, Mo., will be glad to send you bulletins describing their two-cycle gas and oil engines. Weber engines have been manufactured in Kansas City for more than 40 years and have been sold principally in the oil fields, where they have earned an enviable reputation as reliable power units in such work as oil well drilling, pumping, pipe-line service, etc. This company also manufactures gray iron and semi-steel castings, and an inquiry, stating your requirements, will bring a prompt response.

De Laval
Pumps at St. Louis

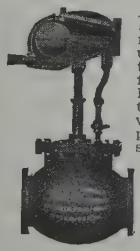
THIS photograph, taken in the new Howard Bend Pumping Station of the St. Louis Water Works, shows the three De Laval turbine-driven low head units, two of 60 m. g. d., and one of 120 m. g. d., all against 40 ft. head. The same station will contain two De Laval geared turbine driven centrifugal pumps to deliver 60 m. g. d. each against 360 ft. head, believed to be the largest turbine-driven water works pumps ever built. The purchase of the De Laval units by the St. Louis Water Department was decided upon only after months of exhaustive investigation and careful analysis, including visits of inspection to pumping stations and manufacturing plants throughout the country.

DE LAVAL STEAM TURBINE CO.
Trenton, New Jersey

4015

GOLDEN-ANDERSON

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves



Adapted to automatically maintain a uniform water level in feed - water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

Automatic "Cushioned" Controlling Altitude Valves

REMEMBER
Valves cushioned at all times by air and water. No water hammer or bursting mains.

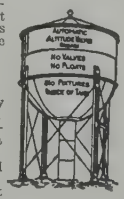
Cushion All Water Surges

Automatically maintains a constant stage of water in reservoirs, tanks and standpipes. They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer. There are no dangerous surges to burst water mains. **Write for details.**



"Made with stop starter attachment for centrifugal pumps."

Golden-Anderson Valve Specialty Co.
1385 Fulton Bldg., Pittsburgh, Pa.

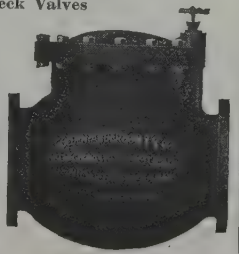
GOLDEN-ANDERSON
Patent Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves



1. Especially adapted for Water Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering or Sticking.
4. Globe or Angle Patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.

Sizes ½" to 24".

2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal - to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.

Concrete Delivery Body.—The R. C. M. delivery tank for the delivery of wet concrete from a central mixing plant is described in a folder issued by the Portland Concrete Machines Co., 53 W. Jackson Blvd., Chicago. This tank, which is hermetically sealed during delivery, is arranged to rotate while the concrete is being conveyed. Internal vanes tend to promote uniformity throughout the mass of concrete. The tank can be installed on any standard truck chassis. The folder will be sent upon request.

Rotary Pumps.—The latest addition to the Luitwieler pump family is the Luitwieler "Multipellor"— a deep-well rotary pump, designed for wells larger than 4 in., where more water is desired than the piston type will deliver. No lubrication is required in this pump, since the only bearings are built into the motor. The Luitwieler Pumping Methods Engine Co., 123 Ames St., Rochester, N. Y., will be glad to send you information on this new pump.

Air Compressors and Exhausters.—The Allen Air Appliance Co., 452 Lexington Ave., New York, N. Y., will be glad to send you their Bulletin No. A-50, describing uses of "Triple-A" air appliances. The booklet is illustrated, and a perusal of it will repay anyone who has a possible job for air.

Water Controlling Apparatus.—Write to Rodney Hunt Machine Co., 101 Lake St., Orange, Mass., for information which will help you check power losses, in trash racks, head gates, hoists and penstocks.

Cast-Iron Pipe.—The McWane Cast Iron Pipe Co., Birmingham, Ala., will be glad to mail you their photo news service, "McWane Pipe Pointers."

Pump Data.—The Chicago Pump Co. announces the completion of a bulletin entitled "Useful Information," which contains miscellaneous tables having to do with pumps and hydraulics, plus an abundance of information pertaining to centrifugal pumps. The information in this bulletin is the result of actual practice in the pump field over a period of 20 years. The bulletin answers questions which are asked every day by architects, engineers and plumbing contractors. "Useful Information" was compiled by the president of the Chicago Pump Co., Mr. M. I. Weil, whose many years of association with centrifugal pumps qualify him to help those who have centrifugal pump problems. The bulletin will be mailed to all those requesting it. Write to the Chicago Pump Co., 2300-36 Wolfram St., Chicago.

Air Compressors and Tools.—Write to the Ingersoll-Rand Co., 11 Broadway, New York, N. Y., for the latest bulletin describing Ingersoll-Rand portable air compressors and tools. Machines are available for rock drilling and pavement breaking, trench digging and backfilling, hoisting and hauling, grinding and surfacing, riveting, sheet pile driving, spray painting, tie tamping, etc. A table is included, giving the number of Ingersoll-Rand tools that each size of Ingersoll-Rand portable compressor will operate in general service.

Centrifugal Pumps.—Fig. 520 Fairbanks-Morse centrifugal pumps are described in Bulletin No. 5015 of Fairbanks, Morse & Co., Chicago, Ill. Tables giving sizes and capacities and dimensions are included. Copies will be supplied upon request.

Drill Steel Sharpener.—The Sullivan Machinery Co. has just published a new bulletin on its light model drill steel sharpener, class "C." This bulletin, No. 72-N, contains 16 pages and is fully illustrated with details of the sharpener and pictures of the machine at work. This sharpener is suitable for work on hammer drill bits and shanks for the lighter drills, and is also effective for making pick and chisel point bits for concrete breakers and similar tools. As in all Sullivan sharpeners, the "all-hammer" principle of upsetting and swaging the steel is employed, thus retaining the original quality of the steel and increasing its toughness and resistance to wear. Copies of this new bulletin will be sent upon request to the Sullivan Machinery Co., 400 North Michigan Ave., Chicago.

Rotary Soil Screens.—A recent folder describes four models of the Converse rotary soil screen, manufactured by the F. S. Converse Co., Inc., Johnson City, N. Y. Data are presented to prove that a rotary soil screen pays for itself in one season on an 18-hole golf course. The bulletin contains prices of complete units and accessories. The manufacturers will be glad to send you a copy.

Air Compressors.—Bulletin No. 147 of the Pennsylvania Pump & Compressor Co., Easton, Pa., describing Pennsylvania single-stage air compressors, is now ready for distribution. This bulletin contains an interesting cross-sectional view of a Pennsylvania class 3-A compressor, together with a description and illustrations of Pennsylvania methods of compressor regulation. Tables giving sizes, capacities and ratings are included. Copies are available.

Hood Pneumatic Tires.—The Hood Tire Co. has issued two booklets, "A New Leader Among the Giant Pneumatics" and "How to Get More Mileage and Better Service from Pneumatic Truck Tires." As indicated, the former is the story of the Hood truck tire, whilst the latter contains information and suggestions for truck drivers. The manufacturers will be pleased to send you copies.

Rotary Pumps.—The Geo. D. Roper Corp., of Rockford, Ill., has issued a 16-page booklet presenting Trahern rotary pumps for a multitude of uses. Various installations are set forth and valuable data tables are presented, giving dimensions and capacities of the several units. A copy may be secured upon application.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Water Works and Sewerage, published monthly at Hammond, Indiana, for October 1, 1929.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Water Works and Sewerage and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Gillette Publishing Company, 221 E. 20th St., Chicago, Ill.

Editor—H. P. Gillette, 221 E. 20th St., Chicago, Ill.

Managing Editor—C. T. Murray, 221 E. 20th St., Chicago, Ill.

Business Manager—E. S. Gillette, 221 E. 20th St., Chicago, Ill.

2.—That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Gillette Publishing Company, 221 E. 20th St., Chicago, Ill.

H. P. Gillette, 221 E. 20th St., Chicago, Ill.

E. S. Gillette, 221 E. 20th St., Chicago, Ill.

Mrs. R. W. Hume, 303 S. Stone Ave., LaGrange, Ill.

Winifred Gillette, 1125 Oak Grove Ave., San Marino, Calif.

Commonwealth Title Ins. & Trust Co., Chestnut and 12th Sts., Philadelphia, Pa.

Louise Forsythe, 13 E. Windermere Terrace, Lansdowne, Pa.

LaVerne Louer Hellyer, Ambassador Hotel, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is—(This information is required from daily publications only.)

E. S. GILLETTE,
(Signature of Business Manager.)

Sworn to and subscribed before me this 23rd day of September, A. D. 1929.

(Seal) KITTIE C. WOULFE.
(My commisison expires Feb. 9, 1930.)

BIG AND LITTLE, RICH AND POOR, CAN PROJECT THEIR PERSONALITIES OVER THE WIDE NETWORK OF ITS WIRES

In the service of all the people

An Advertisement of the
American Telephone and Telegraph Company

THE Bell System is owned by 450,000 stockholders and operated by more than 400,000 workers for the service of the people of the nation.

It is a democratic instrument of a democracy. Big and little, rich and poor, can project their personalities over the wide network of its wires. For friendship or business, pleasure or profit, the telephone is indispensable to our modern civilization.

This year the Bell System is erecting new telephone buildings in more than 200 cities. It is putting in thousands of miles of cable, thousands of sections of switchboard and hundreds of thousands of new telephones. Its expenditure for plant and improvements in service in 1929 will be more than 550 millions of dollars—half again as much as it cost to build the Panama Canal.

This program is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Harlow H. Curtice

Thirty-six year-old executive recently appointed president and general manager of A. C. Spark Plug Company to succeed Basil W. deGuichard

Water Tapping Invention Starts Mighty Industry

Necessity that same old mother that has brought into the world so many inventions started Hieronymus Mueller, founder of Mueller Company, Decatur, on a course of events which has resulted in an establishment with an annual payroll of approximately $2,000,000.

This aforementioned Hieronymus Mueller came to this country from Germany in 1849 and after trying out Chicago and Freeport decided that Decatur was to be his future home. This was in 1857. Mr. Mueller was a mechanic and for many years conducted a gun and locksmith shop. But being a mechanic he understood the needs of water works and when Decatur built a water works plant he became the city plumber.

In 1881, when Mr. Mueller was 49 years old, he was called on in his capacity of plumber to tap a water main. Before the work was successfully completed Mr. Mueller had to drive to the pumping station to have water shut off, and after the connection was made had to drive back to have the water turned on. Enough to make a good plumber think, way back in the days when there were no telephones and no automobiles to speed things up.

So it was that Mr. Mueller decided to invent a machine to tap a water main without having to shut off the water. The machine worked and he patented it and proceeded to manufacture it for the benefit of water works men all over the country. To make the cocks required for this machine as they should be, resulted in starting a small brass foundry, and now this branch of the Mueller Company manufacture tapping and drilling machines, water works brass and iron goods and plumbing brass goods.

The vitreous ware plant now forms one of the most important branches of the Mueller works. Here clay brought from Kentucky, Tennessee, New Jersey and even Europe is operated on and turned out in finished sanitary bathroom furniture. The plant has a capacity of turning out 500 pieces a day and keeps a hundred skilled workmen busy.

Altogether 1,500 workmen share in the $2,000,000 annual payroll of the Mueller Company, which is now operated by six sons of the founder, the president and general manager being Mr. Adolph Mueller. Mr. Hieronymus Mueller, inventor of the tapping machine which is now used by practically 90 per cent of the water works throughout the country died in 1900.

Headley Emulsified Products Succeeds Headley Good Roads

The Headley Emulsified Products Company, on October first, became the successor to Headley Good Roads Company of Philadelphia, who for 21 years have manufactured emulsified asphalt products. The new company it is stated will expand this line to cover all of the following industrial uses: Highway construction and maintenance, railroad platforms and crossings, waterproofing, dampproofing and protective coatings for all types of structures.

The officers of the new corporation are: President, Edgar S. Ross, Director of Research and Development of the old company, and formerly in charge of investigations on roofings and waterproofings at the Mellon Institute of Industrial Research; Vice-President, Parmely W. Herrick, of the Herrick Company, Cleveland, Ohio; Vice-President and Treasurer, M. W. Lefever, for 15 years in a similar position with the Headley Good Roads Company; Secretary, Geo. D. Webster, Esq., of Cleveland.

According to announcement the present plant at Marcus Hook, Pa., will be supplemented by other manufacturing facilities to be located at points not yet determined.

"Caterpillar" Appoints Chambers Western Manager

H. H. Chambers has been appointed sales manager of the western division with headquarters at San Leandro, California, for the Caterpillar Tractor Company.

Mr. Chambers succeeds I. E. Jones, who according to announcement issued by the company, is embarking on an extended trip through foreign lands in the interests of the export sales division. E. I. Stoffer, former district representative in Pennsylvania and New York for Caterpillar, will take Chambers' place in the eastern division.

The appointment of Mr. Chambers to his new position is announced as a promotion, his connection with the company having started fourteen years ago as a laborer on the assembly line, where he spent three years. He served in the army during the World War and rejoined the Caterpillar company as a member of the sales promotion and advertising department. Later he spent three years as salesman and general manager for a Wisconsin Caterpillar dealer.

H. H. Chambers, Newly Appointed Western Sales Manager for Caterpillar Tractor Co.

Can you think of anything that will last longer than a vitrified clay sewer?

CLAY PRODUCTS ASSOCIATION
CONWAY BUILDING
Chicago

VITRIFIED Salt Glazed CLAY
Sanitary Sewer Pipe

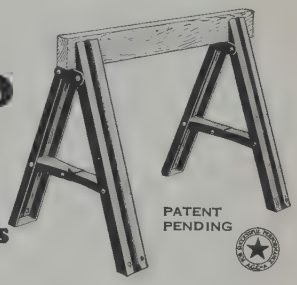
WW 12-Gray

A Quick Set-up
for a short job

Every day small jobs on the street require temporary protecting barricades like this.

This one was made with a single board and a pair of TOLEDO HORSE frames. When the job was done, it was knocked down in just a few seconds, and tossed under the seat of a small truck all ready to set up as quickly on the next job.

THE TOLEDO HORSE
meets all requirements of

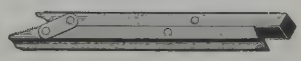


utility, — *Aside from barricades, there are hundreds of ways every user will find them convenient.*

safety, — *They are absolutely rigid, and if necessary one pair will support twelve ton.*

convenience and economy — *They use any piece of handy lumber, are fully collapsible, and can be carried or stored in very small space.*

They are indestructible and will last indefinitely, without repairs.



See them at your dealer's, or write us for full details.

THE
Toledo Pressed Steel Co.
TOLEDO :: OHIO

Maurer, Prominent in Wisconsin Highway Affairs, Joins Heil Company

The Heil Co. announces the recent appointment of Mr. C. N. Maurer, a prominent figure with the Wisconsin State Highway Commission for the past ten years, as Director of the Highway Sales Division of the Heil Co.

Mr. Maurer has recently been highly acclaimed for one of his outstanding achievements as traffic engineer of the Highway Commission namely, formulating the new Wisconsin Traffic Code which became effective November 4th, 1929.

Mr. Maurer's first big assignment with the Highway Commission was the securing, reconditioning and distributing of surplus war equipment to the counties. Over a period of six years he supervised the allocation of several millions of dollars worth of surplus war equipment.

C. N. Maurer

When this job was completed Mr. Maurer was appointed Traffic Engineer of the Highway Commission. In this capacity he supervised the remarking of all Wisconsin Highways, installed the department to handle the weight law enforcement of vehicles and developed the State Highway Arterial System.

These activities over a period of years formed a splendid background for preparation of the State Traffic Code.

Mr. Maurer is a graduate mechanical engineer of the University of Wisconsin. He was a First Lieutenant during the war with a 19 months overseas service record. He is a member of the Society of Automotive Engineers and Wisconsin Engineering Society; Chairman of the Board of Directors of the Madison, Wisconsin, American Automobile Association, and also the Wisconsin Member to the A. A. A. National Good Roads Committee.

Mr. Maurer joins the Heil Co. with a broad understanding of Highway development work. His experience admirably fits him for his new work in representing Heil Hydraulic Hoists and Heil All-Steel Dump Bodies for motor trucks.

Hardinge Company Announcement

Mr. Howard G. Wright, formerly chief engineer of the North American Cement Company, Catskill, New York, has joined the staff of the Hardinge Company as research engineer in the cement machinery department. Mr. Wright will devote a large part of his time to working up engineering data for the various classes of Hardinge equipment used in cement plants, according to announcement.

Mr. John L. Mason, formerly sanitary engineer for the Water Works Supply Company, San Francisco, California, has become sewage research engineer for the Hardinge Company. Mr. Mason collaborated in the development of the "Watsco" Aerator for the activated sludge treatment of sewage, and has had extensive experience in the far west in the design and manufacture of mechanical equipment installed in sanitation plants.

Lockwood Hill Forms Equipment Company

Announcement has been made to the effect that Lockwood Hill, for the past ten years a member of the Blackman Hill Company of St. Louis, Mo., has organized a new company to be known as the Hill Equipment Engineering Company with offices at 4620 Delmar Boulevard, St. Louis.

Announcement states that the new organization is to have the exclusive sale of the products of the Lincoln Electric Company, and the Baker Industrial Truck Company in the St. Louis Metropolitan District, and the Eastern Missouri and Southern Illinois territories. The company will carry a complete stock of "Linc-Weld" motors and "Stable-Arc" welders, welding supplies, accessories and parts.

Prior to his association with the Blackman Hill Company, Mr. Hill was assistant to price approval officer in the St. Louis district ordinance office of the U. S. Army. He also served in the testing and foreign departments of the General Electric Company, and in the power and mining department in the St. Louis district office of this company.

It is said that early in Mr. Hill's business career he sold the first arc welders in the St. Louis territory. He is a graduate of the class of 1909, Cornell University, where he received his degree in mechanical engineering and a certificate in electrical engineering.

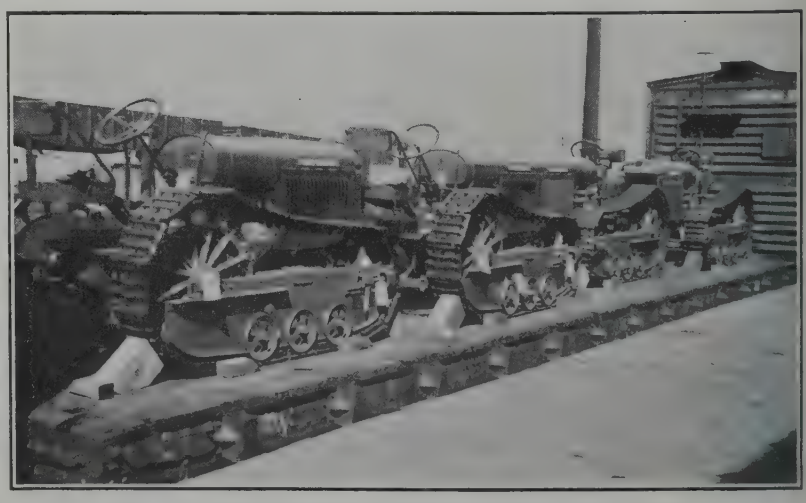
Announcement

The Independent Pneumatic Tool Company, 600 W. Jackson Boulevard, Chicago, announces the following organization changes:

Mr. Joseph P. Fletcher, manager of the company's Buffalo office, has been appointed manager of the Philadelphia office to succeed the late Mr. A. L. Schuhl.

Mr. W. O. Becker, who has been working out of the Toronto office, has been named as manager of the Buffalo office to succeed Mr. Fletcher.

E. F. Doty Pump Co., Inc., manufacturers of corrosion resisting pumps of various alloys, announce that they are now manufacturing rubber lined and covered centrifugal pumps. The surfaces in contact with corrosive fluids are covered with rubber by B. F. Goodrich Rubber Co's. "Vulcalock" process. These pumps have been developed in sizes up to 6 in. discharge. Headquarters of the Doty Pump Company are located at 401 Ellicott Sq., Buffalo, New York City.



Fleet of 24 Model LH Trackson McCormick Deerings on Way to Texas

GOLDEN-ANDERSON

GOLDEN-ANDERSON

Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed - water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

Automatic "Cushioned" Controlling Altitude Valves

Cushion All Water Surges

Automatically maintains a constant stage of water in reservoirs, tanks and standpipes. They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer. There are no dangerous surges to burst water mains. **Write for details.**

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Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

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Patent Cushioned Water Relief Valves

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4. Perfect air and water cushioning.
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6. Angle and globe pattern. Sizes 3 to 24-in.

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Pat. Automatic Cushioned Water Pressure Regulating Valves

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2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering, or Sticking.
4. Globe or Angle Patterns up to 24 in.
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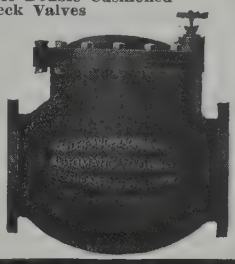

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Sizes ½" to 24".

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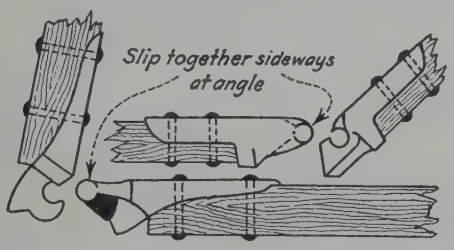
Water Cleaning System, if you wish it, or Drag Bucket type.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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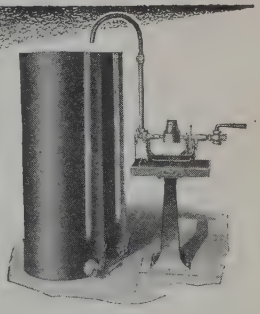

WHATEVER your meter testing requirements are, Ford Testers handle the work economically and conveniently.

Standard testers take one, three, four or five meters at a time. We have built special testers for six, eight, ten and twelve meters in a series. Each meter is clamped in separately. Units can be adapted in a few seconds for ⅝", ¾", or 1" meters, and with special clamp will take 1¼", 1½" and 2" meters.

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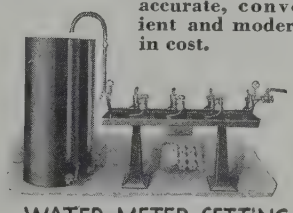

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Chicago Water Department, —Four 5-unit and one 1-unit tester.
Philadelphia Water Dept. —Four 12-unit, two 10 unit and one 8-unit tester.
Indianapolis Water Co. —Two 5-unit testers.
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Community Water Ser. Co. —Two 5-unit, and two 1-unit testers.
Cincinnati Water Dept. —One 4-unit tester.
Youngstown, O. Water Dept. —Two 5-unit testers.
University of Delaware —One 5-unit tester.

WATER METER SETTING & TESTING EQUIPMENT

The FORD METER BOX Co.
WABASH - INDIANA

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addesses furnished interested persons upon request.

New Lines Wanted

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Distributors of contractors' and builders' machinery and equipment are seeking line of road forms, road finishers, batcher plants, clamshell buckets and drag line buckets, for northern California terirtory. Now stocking equipment for several well known machinery manufacturers.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Equipment distributor located in Michigan desires to add two or three good lines to serve territory in southeastern part of state.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

Distributor thoroughly familiar with bituminous materials and equipment for handling, wishes to add to present lines. Covers Wisconsin and Illinois territory.

Representatives Wanted

Manufacturer of truck, adapted to many uses, has attractive territory open in Missouri, Kentucky, Kansas, Nebraska and several southern states.

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of excavating equipment desires to build up distribution organization throughout the country.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of two-cycle oil and gas engines, in sizes from 30 to 125 hp., adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Attractive territory available for experienced men to handle contractors' labor-saving equipment by old established company. Equipment backed by national advertising.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

Manufacturer of metal lath, corner beads, channels and reinforcing mesh desires to secure distributors for products in the southwest and middlewest.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of mechanical spreaders for cover material desires representation by organizations covering entire states. Several desirable states are still open. Number of inquiries now on hand for spreaders require immediate follow up.

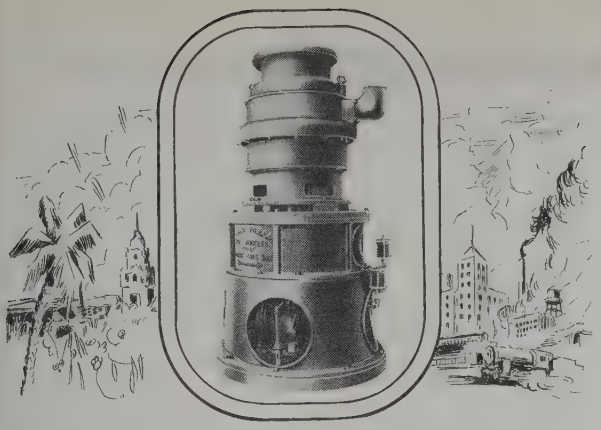
Manufacturer of automatic dipper trip, adapted to any type shovel (steam, gasoline, diesel, electric, etc.); with rapidly growing business, is seeking additional representatives.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of rotary pump, especially designed for road construction work, has proposition for reliable distribution houses.

Good side-line offered to manufacturers' representatives covering municipalities and public institutions.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.



The Choice of Cities

Dependable water supply being highly essential to municipalities, it is only natural that so many of the city engineers, who have thoroughly investigated the functions dependent upon efficient pumps, should specify PEERLESS to insure satisfactory service with the least maintenance expense.

Illustrated literature free upon request. No cost or obligation—just write Department W.

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Factories: Los Angeles, Calif., Massillon, Ohio
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DISTRIBUTORS IN ALL PRINCIPAL CITIES

NORWOOD

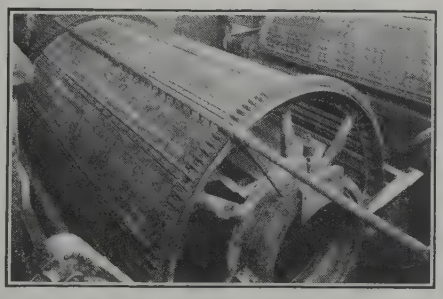
Municipal Filtration Plants

are giving such satisfactory service wherever in service that water works officials considering such equipment will find that it pays to write us for complete information before placing their orders.

Write for Full Details

Norwood Engineering Company

Florence, Massachusetts



At Flankington plant

The North Sewage Screen

A clarifier which removes and aerates the effluent. Liquids go through perforations finer than a cambric needle.

Saves byproducts in a dry state.

Doubles capacity of old sewage plants. Decreases cost of new disposal plants.

Is all you need if effluent discharges into large streams.

The only *fine* screen on the market.

GREEN BAY FOUNDRY & MACHINE WORKS
GREEN BAY, WIS.

"NO VISIBLE SOLIDS IN EFFLUENT"

Bourbon Fire Hydrants, Gate Valves and Extension Valve Boxes

Water Works and Fire Department Supplies

The Bourbon Copper and Brass Works Co.

618-620 E. Front St. Cincinnati, Ohio

USEFUL EQUIPMENT INFORMATION

Water Plants.—"Municipal Water Works" is the title of a booklet recently issued by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. In addition to building storage tanks, this company is equipped to execute contracts for complete water works systems. The booklet describes various installations. Several useful tables are included.

Cement-Lined Pipe.—The Cement-Lined Pipe Co., Lynn, Mass., will be pleased to send "Cement-Lined Pipe for Corrosive Waters," a thorough discussion of the uses and advantages of water pipe lined with cement. Tables of weights and comparative costs are included.

Meters and Accessories.—The Pittsburg Equitable Meter Co., Pittsburgh, Pa., will be glad to send illustrated booklets covering meters, testing apparatus and various accessories for the meter department. The booklets contain drawings, specifications and tables of dimensions.

Refuse Disposal.—A valuable book for all who are concerned with the problem of refuse disposal is "Disposal of Municipal Refuse by Incineration." Whoever is planning or operating a disposal plant, municipal or private, should have this book. A copy may be secured from the Morse Boulger Destructor Co., 205 E. 42d St., New York, N. Y.

Moore Speedcrane.—The latest catalog of the Manitowoc Engineering Works, Manitowoc, Wis., describing the Moore "Speedcrane" shovel, dragline and trenchoe, presents a number of advanced features incorporated in this equipment. A copy may be secured by writing to the manufacturers.

Baker Bulldozers.—Bulletin No. 273 of the Baker Mfg. Co., Springfield, Ill., presents Baker hydraulic bulldozers for Caterpillar "30" and "60" tractors. A copy will be sent upon application.

Samplers and Mixers.—"Samplitt," a device by which samples of liquid are automatically secured from pipe lines as the liquid passes through the line, and "Mixitt," a device by which a small amount of one liquid is automatically injected into another in predetermined and adjustable percentages as the liquid requiring treatment flows through a pipe line, are described in bulletins issued by the Max B. Miller & Co., Inc., New York, N. Y. Tables for choosing sizes of these devices for various uses and conditions are included.

Rensselaer Valves.—The Rensselaer Valve Co., Troy, N. Y., will be pleased to send booklets and folders describing Rensselaer valves, tapping sleeves, crosses, repair sleeves, etc.

By writing the manufacturers named and mentioning this magazine, copies of the catalogs listed below will be sent you without obligation.

Copper Pipe Coupling.—A convenient booklet describing Anderson couplings for copper service pipe is issued by the Chapman Valve Mfg. Co., Indian Orchard, Mass. Specifications for copper service tubes are included.

Boilers.—The Erie City Iron Works, Erie, Pa., has recently issued two booklets, one of 16 pages covering the Erie City 3-drum boiler and one of 12 pages describing and illustrating the "Economic" boiler. A feature of the "Economic" booklet is a large phantom view with the principal points of construction indicated by arrows.

Diesel Engine Catalog.—An attractive 24-page catalog describing their new vertical diesel engine has been issued by the Buckeye Machine Co., of Lima, O. Copies are available to anyone interested.

Valves and Fittings.—The new Reading-Pratt & Cady catalog, No. 300, covers Pratt & Cady iron and bronze valves and asbestos-packed cocks, and Reading cast-steel valves and fittings. It includes much valuable information for the engineer, steamfitter and plumber. The catalog will be found a handy reference book for engineers, purchasing agents and anyone else interested in piping systems and valves and fittings. Copies may be secured by writing to the Reading Steel Casting Co., Inc., Bridgeport, Conn.

High-Temperature Cement.—"Firebond," a high-temperature cement, is described in a booklet recently issued by the Harbison-Walker Refractories Co., Pittsburgh, Pa. This booklet contains some new and useful tables for calculating the quantities of brick required for arches of different spans and thicknesses. These tables should be of interest to anyone connected with firebrick construction. The manufacturers will be pleased to send a copy to those interested.

Water Works Tools and Supplies.—Valves, hydrants, valve inserting machines, tapping machines, pipe cutters and other water works tools and supplies are described in a catalog of the A. P. Smith Mfg. Co., East Orange, N. J. Every water works superintendent should have a copy of this catalog.

For Recording Bids.—A convenience for contractors and officials alike is a bid record book, published by the United States Cast-Iron Pipe & Foundry Co., Burlington, N. J. It contains a table of standard thicknesses and weights of cast-iron pipe.

Federal Meters.—The latest Federal meters are presented in a bulletin of the Federal Meter Corp., East Orange, N. J. A copy will be sent upon application.

Incinerators.—A useful discussion of incineration, an account of the design and manufacture of "United States Standard" incinerators and a series of brief descriptions of installations of these incinerators are contained in a booklet issued by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. Personal service in the matter of choice of a system of municipal refuse disposal is offered city officials by the Pittsburgh-Des Moines organization.

Venturi Meters.—Two booklets, "The Venturi Meter for Main Pipe Lines" and "Filtration Plant Equipment," have been issued by the Builders Iron Foundry, Providence, R. I. Valuable data for plant designers and all who are concerned with the measurement of flow in large pipe lines are contained within these bulletins. The type KS shunt meter, also manufactured by this foundry, is described in a leaflet which gives useful capacity tables.

Forced-Draft Fans.—The use of low grade, cheap fuels has been made possible in the last few years by the adoption of small forced-draft fans and special grates on domestic and other small furnaces and boilers. The American Blower Corp. has published a catalog showing standard forced-draft fans suitable for this use. The catalog also gives application and technical data of interest to any who contemplate installations of this kind. It is claimed that the use of the cheaper grades of fuel will pay for the necessary equipment in a very short time without loss of heating efficiency in the furnace. It is also claimed that the use of the forced-draft blower gives quicker "heating up" capacity and more flexible operation. The American Blower Corp., Detroit, Mich., will be glad to send a copy of their bulletin No. 10401 on this subject upon request.

Municipal Castings.—Clark municipal castings, service boxes, meter boxes and valve housings are described and illustrated in bulletins of the H. W. Clark Co., Mattoon, Ill. An inquiry will bring information on all Clark products.

FOREWORD

GILLETTE PUBLISHING COMPANY presents herewith the first edition of the Water Works and Sewerage Data Section of Municipal News and Water Works.

The Data Section has been prepared by Mr. Halbert P. Gillette and gives the equivalent of a 300 page handbook of data on the design, construction, operation and maintenance of water works and sewerage.

The Data Section together with the Geographical Index of dealers and distributors together with the manufacturers' data makes the edition a very complete and practical reference issue.

The demand for copies of this issue has been so great that the edition will be distributed to 16,000.

The Data Section is carefully selected matter from the files of Municipal News and Water Works and from other sources named in the text. In addition, scores of letters have been written to secure the latest hydraulic tables and standards and the most economical methods. In a word, the same conscientious work has been put into the writing of the Data Section as would be expected in a book devoted exclusively to this purpose.

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Aftercoolers, Air
Chicago Pneumatic Tool Co., New York City.
Ingersoll-Rand Co., New York City.
Sullivan Machy. Co., 819 Wrigley Bldg., Chicago, Ill.

Air Ducts, Steel
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Littleford Bros., 454 E. Pearl St., Cinnati, O.

Air Lifts
Chicago Pneumatic Tool Co., New York, N. Y.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Asbestos Lead Lined Runners
Coleman, Allan J., Chicago, Ill.

Asbestos Specialties
Philip Carey Co., Cincinnati, O.

Ash Handling Machinery
Haiss Mfg. Co., Geo., New York City.

Asphalt
Asphalt Association, New York City.
Barrett Co., New York City.
Kentucky Rock Asphalt Co., Louisville, Ky.
Servicised Products Corp., Chicago, Ill.
Standard Oil Co. of Indiana, Chicago
Standard Oil Co. of N. Y., New York City.
The Texas Co., New York City.
West Process Pavement Co., Louisville, Ky.

Asphalt Pavement Repair Outfits
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
The Rightway Corporation, 228 N. La Salle St., Chicago, Ill.

Asphalt Plants, Portable
E. D. Entyre & Co., Inc., 63 Jefferson St., Oregon, Ill.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
The Rightway Corporation, 228 N. La Salle St., Chicago, Ill.

Augers, Pipe
Coleman, Allen, Chicago, Ill.

Axles
Electric Wheel Co., Quincy, Ill.

Back-Fillers
American Cement Machine Co., 251 E. Fourth St., Keokuk, Ia.
The Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Buckeye Traction Ditcher Co., Findlay, Ohio.
Bucyrus-Erie Co., Erie, Pa.
Buss Machine Co., Ravenna, O.
Chicago Pneumatic Tool Co., New York.
Galion Iron Works, Galion, O.
General Excavator Co., Marion, O.
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brownhoist Co., Cleveland.
Keystone Driller Co., Beaver Falls, Pa.
Ohio Power Shovel Co., Lima, O.
Speeder Machinery Co., Cedar Rapids, Ia.

Back Stopers
Adams Co., J. D., Indianapolis, Ind.

Bags, Paper Cement
Bates Valve Bag Corp., Chicago.

Bar Benders & Cutters
Koehring Company, Milwaukee, Wis.
Ransome Concrete Machinery Co., Dunnellen, N. J.

Bar Chairs, Reinforcing
Concrete Steel Co., New York City.

Bars, Iron & Steel
Concrete Steel Co., New York City.
Ryerson & Son, Joseph T., Chicago.

Bars, Iron & Steel Reinforcing
American Steel & Wire Co., Chicago.
Truscon Steel Co., Youngstown, O.

Batch Boxes
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Heltzel Steel Form & Iron Co., Warren, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Western Wheeled Scraper Co., Aurora, Ill.

Batchers, Adjustable
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Butler Bin Co., Waukesha, Wis.
Erie Steel Construction Co., Erie, Pa.
Heltzel Steel Form & Iron Co., Warren, O.
Johnson Company, C. S., Champaign, Ill.

Batcher Plants
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Erie Steel Construction Co., Erie, Pa.

Beams
Carnegie Steel Co., Pittsburgh, Pa.
Ryerson & Son, Joseph T., Chicago.

Bearings
Hyatt Roller Bearing Co., Harrison, N. J.
S. K. F. Industries, New York, N. Y.
Timken Roller Bearing Co., Canton, O.

Binders, Paving
American Tar Products Corp., Pittsburgh, Pa.
Barrett Co., New York City.
Philip Carey Co., Cincinnati, O.
Kentucky Rock Asphalt Co., Louisville.
Servicised Products Corp., Chicago.
Standard Oil Co. of Indiana, Chicago.
Standard Oil Co. of New York, New York City.
The Texas Co., New York City.

Bins, Storage
Butler Bin Co., Waukesha, Wis.
Johnson Company, C. S., Champaign, Ill.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

Blades, Grader
J. D. Adams Co., Indianapolis, Ind.

Blocks, Tackle
Western Block Co., Lockport, N. Y.
Williamsport Wire Rope Co., Williamsport, Pa.

Bodies, Meter Box
Clark Co., H. W., Mattoon, Ill.

Bodies, Truck
Anthony Co., Streator, Ill.
Galion All Steel Body Co., Galion, O.
Lee Trailer & Body Co., Plymouth, Ind.
Wood Hydraulic Hoist & Body, Detroit.

Boilers, Steam
Orr & Sembower, Reading, Pa.

Boilers, Steel
Central Foundry Co., New York City.
R. D. Cole Mfg. Co., Newnan, Ga.
Industrial Brownhoist Co., Cleveland.

Bolts, Nails, Nuts, Rivets & Spikes
Ryerson & Son, Joseph T., Chicago.

Books, Engr. and Tech.
Gillette Publishing Co., Chicago, Ill.

Bowls, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.

Boxes, Annealing
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Boxes, Meter
Clark Co., H. W., Mattoon, Ill.
Reading Meter Repair Co., Reading, Pa.

Braces, Trench
Kalamazoo Fdry. & Mach. Co., Kalamazoo, Mich.

Brands, Tool
Chicago Pneumatic Tool Co., New York City.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Ingersoll-Rand Co., New York City.

Breechings, Steel
R. D. Cole Mfg. Co., Newnan, Ga.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Brick
Hydraulic-Press Brick Co., St. Louis, Mo.
National Paving Brick Mfrs. Assn., Washington.

Brick, Enamel
Hydraulic-Press Brick Co., St. Louis, Mo.

Brick Loaders and Unloaders
Haiss Mfg. Co., Geo., New York City.

Brick, Mosaics
Hydraulic-Press Brick Co., St. Louis, Co.

Brick, Paving
National Paving Brick Mfrs. Assn., Chicago.

Brick, Salt Glaze
Hydraulic-Press Brick Co., St. Louis, Mo.

Brick, Vitrified
National Paving Brick Mfrs. Assn., Chicago.

Bridges
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Bridge Accessories
Armco Culvert & Flume Co., Middletown, O.
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.
J. T. Ryerson & Sons, Chicago.
Wood Steel Co., Alan, Conshohocken, Pa.

Bridges, Suspension
John A. Roebling's Sons Co., Trenton, N. J.

Buckets, Back Filling
Garst Mfg. Co., Chicago.

Buckets, Clam Shell
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Erie Steel Construction Co., Erie, Pa.
Haiss Mfg. Co., Inc., Geo., New York.
Hayward Co., New York City.
Industrial Brownhoist Corp., Cleveland.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Orton Crane & Shovel Co., Chicago, Ill.
William Co., G. H., Erie, Pa.

Buckets, Concrete
Insley Mfg. Co., Indianapolis, Ind.
Ransome Concrete Mchry. Co., Dunnellen, N. J.

Buckets, Contractors
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Buckets, Dragline
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Harnischfeger Corp., Milwaukee, Wis.
Hayward Co., New York City.
Williams Company, G. H., Erie, Pa.

Buckets, Dredging and Excavating
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Garst Mfg. Co., Chicago.
Haiss Mfg. Co., Inc., Geo., New York.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Company, Marion, O.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.
The T. L. Smith Co., 1031 32nd St., Milwaukee, Wis.
Williams Co., G. H., Erie, Pa.

Buckets, Excavating
Haiss Mfg. Co., Geo., New York City.
Harnischfeger Corp., Milwaukee, Wis.

Buckets, Orange Peel
Hayward Co., New York City.
G. H. Williams Co., Erie, Pa.

Buckets, Self Filling
Pioneer Gravel Equipment Co., Minneapolis, Minn.

Building Paper
Barrett Co., New York City

Buildings, Steel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Bulldozers
The Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Trackson Co., Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.

Burners, Furnace
Acroil Burner Co., Union Hill, N. J.
Hauck Mfg. Co., Brooklyn, N. Y.

Bushings, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.

Cableways
American Steel & Wire Co., Chicago.
Hayward Company, New York City.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.
Wickwire Spencer Steel Co., New York City.

Cableway Excavators
(See Excavators, Cableway.)

Calcium Chloride
Columbia Products Co., Barberton, O.
Sales Agents Special Products, Columbia Chemical Division, Pittsburgh Plate Glass Co.
Dowflake Chemical Co., Midland, Mich.
Pittsburgh Plate Glass Co., Barberton, Ohio.
Semet-Solvay Co., 61 Broadway, New York, N. Y.
Solvay Sales Corp., New York City.

Calking Machines
Chicago Pneumatic Tool Co., 6 East 44th St., New York City.
Ingersoll-Rand Co., New York City.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Capstans, Windlasses and Winches
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Fdy. and Machine Co., Bay City, Mich.
Fulton Iron Works Co., St. Louis, Mo
Lidgerwood Mfg. Co., Elizabeth, N. J.

Car Pullers
Lidgerwood Mfg. Co., Elizabeth, N. J.

Car Steps, Safety
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Cars, Rwy.
Fairbanks Morse Co., Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Cars, Industrial V Dump
Insley Mfg. Co., Indianapolis, Ind.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Carts, Concrete
Insley Mfg. Co., Indianapolis, Ind.
Ransome Concrete Mchry. Co., Dunnellen, N. J.

Casings, Well
Armco & Culvert Mfrs. Assn., Middletown, O.

Castings, Builders
Clark Co., H. W., Mattoon, Ill.

Castings, Building
Fulton Iron Works Co., St. Louis, Mo.

Castings, Grey Iron
Fulton Iron Works Co., St. Louis, Mo.

Castings, Iron & Steel
American Casting Co., Birmingham.
Central Foundry Co., New York City.
Central Iron & Steel Co., Harrisburg, Pa.
Clark Co., H. W., Mattoon, Ill.
R. D. Cole Mfg. Co., Newnan, Ga.
Klauer Mfg. Co., Dubuque, Ia.
McWane Cast Iron Pipe Co., Birmingham, Ala.
Marion Steam Shovel Co., Marion, Ohio.
Pacific States Cast Iron Pipe Co., Prova, Utah.
W. A. Riddell Co., Bucyrus, O.
Geo. H. Smith Steel Casting Co., Milwaukee, Wis.
South Bend Fdy. Co., South Bend, Ind.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
Western Crucible Steel Casting Co., Minneapolis, Minn.
Wood, R. D. & Co., Philadelphia, Pa.

Castings, Municipal
Clark Co., H. W., Mattoon, Ill.
Fulton Iron Works Co., St. Louis, Mo.

Castings, Semi-Steel
Fulton Iron Works Co., St. Louis, Mo.

Castings, Street and Sewer
Central Foundry Co., New York City.
Clark Co., H. W., Mattoon, Ill.
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.
Klauer Mfg. Co., Dubuque, Ia.
South Bend Fdy. Co., South Bend, Ind.
U. S. C. I. Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Catch Basins, Corrugated Iron
Armco Culvert Mfrs. Assn., Middletown, O.

Catch Basin Covers
Central Iron & Steel Co., Harrisburg, Pa.
H. W. Clark & Co., Mattoon, Ill.
Galion Iron Works, Galion, O.
U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.

Cement
Philip Carey Co., Cincinnati, O.
International Cement Corp., New York, N. Y.
Marquette Cement Mfg. Co., Chicago, Ill.
Mo. Portland Cement Co., St. Louis, Mo.
Universal Portland Cement Co., 208 S. La Salle St., Chicago, Ill.

Cement Guns
Cement-Gun Co., Inc., Chicago, Ill.

Cement-Making Machinery
Allis-Chalmers Mfg. Co., Milwaukee.

Cementation Process
Dravo Contracting Co., Pittsburgh, Pa.

Centers, Steel, Collapsible
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Chain, Steel & Malleable
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Chemical Feeding Equipment
Bacharach & Co., E. W., Kansas City, Mo.

Chimneys
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
R. D. Cole Mfg. Co., Newnan, Ga.
Connery Company, Philadelphia.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Chloride of Lime
Dow Chemical Co., Midland, Mich.

Chlorine, Liquid
Hooker Electrochemical Co., New York.

Chlorinators
Paradon Mfg. Co., Arlington, N. J.
Wallace and Tiernan, Newark, N. J.

Chutes, Concrete
Insley Mfg. Co., Indianapolis, Ind.
Ransome Concrete Mchry. Co., Dunnellen, N. J.

Clarifiers
Dorr Co., New York City.

Clay, Fire
Clay Products Assn., Chicago.

Clay Spaders
Chicago Pneumatic Tool Co., 6 East 44th St., New York City.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Cleaners, Closet, Flexible Wire
Coleman, Allan, Chicago, Ill.

Closet Cleaner, Chemical Compound
Coleman, Allan, Chicago, Ill.

Clutches
Brown-Lipe Gear Co., Syracuse, N. Y.
Twin Disc Clutch Co., Racine, Wis.

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Coal & Ore-Conveying Machy.
Byers Mch. Co., Ravenna, Ohio.
Haiss Mfg. Co., Inc., Geo., New York.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Coal-Storage Systems
Lidgerwood Mfg. Co., Elizabeth, N. J.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Cofferdams, Steel
Bethlehem Steel Co., Bethlehem, Pa.

Column Forms
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Column, Wrapping
Ryerson & Son, Jos. T., Chicago.

Columns, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.

Compressors, Air, Heavy Duty
Allis-Chalmers Mfg. Co., Milwaukee.
Chicago Pneumatic Tool Co., New York City.
Domestic Engine & Pump Co., Shippensburg, Pa.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Ingersoll-Rand Co., New York City.
O. K. Clutch & Mach. Co., Columbia, Pa.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Compressors, Air, Portable
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Chicago Pneumatic Tool Co., New York City.
Domestic Engine & Pump Co., Shippensburg, Pa.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Ingersoll-Rand Co., New York City.
Novo Engine Co., 220 Porter St., Lansing, Mich.
O. K. Clutch & Mach. Co., Columbia, Pa.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Compressors, Rotary
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Concrete Breakers
Chicago Pneumatic Tool Co., New York.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Concrete, Curing
Dow Chemical Co., Midland, Mich.
Philadelphia Quartz Co., Philadelphia.
Semet-Solvay Co., 61 Broadway, New York, N. Y.

Concrete Heaters
Aeroil Burner Co., West New York, N. J.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Concrete Making Machinery
Koehring Company, Milwaukee, Wis.
Ransome Concrete Mchry. Co., Dunnellen, N. J.

Concrete Mixers
(See Mixers, Concrete.)

Concrete Pipe Machinery
Asphalto Concrete Corp., New York.

Concrete Placing Machinery
Insley Mfg. Co., Indianapolis, Ind.
Jaeger Machine Co., 222 Dublin Ave., Columbus, O.
Ransome Concrete Mach, Co., Dunnellen, N. J.

Concrete Proportioning Equipment
Dravo Equip. Co., Pittsburgh.

Concrete Reinforcement
American Steel & Wire Co., Chicago.
Concrete Steel Co., New York City.
Ryerson & Son, Joseph T., Chicago.
Truscon Steel Co., Youngstown, Pa.
Wickwire Spencer Steel Co., New York.

Concrete, Surface
Concrete Surfacing Machy. Co., Cincinnati, Ohio.

Condensers
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York City.
Manistee Iron Works, Manistee, Mich.

Condensers, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
DeLaval Steam Turb. Co., Trenton, N. J.
Ingersoll-Rand Co., New York City.

Contractors
Cement Gun Constr. Co., Chicago.
Gunite Construction Co., Chicago.

Contractors, Diamond Drill Prospecting
Sullivan Machy. Co., 819 Wrigley Bldg., Chicago, Ill.

Conveyors, Belt
Allis-Chalmers Mfg. Co., Milwaukee.
Austin Western Rd. Mchy. Co., Chicago.
Barber-Greene Co., Aurora, Ill.
Gallon Iron Works, Gallon, O.
Good Roads Machinery Co., Kennett Square, Pa.
Haiss Mfg. Co., Inc., Geo., New York City.
Link Belt Co., 2045 W. Hunting Park Ave. Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Conveyors, Belt & Chain
Chain Belt Co., Milwaukee, Wis.
Haiss Mfg. Co., Geo., New York City.
Industrial Brownhoist Corp., Cleveland.

Conveyors, Brick
Haiss Mfg. Co., Geo., New York City.

Conveyors, Bucket
Haiss Mfg. Co., Inc., Geo., New York.
Industrial Brownhoist Corp., Cleveland.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

Conveyors, Portable
Barber-Greene Co., Aurora, Ill.
Haiss Mfg. Co., Geo., New York City.

Conveyors, Units
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

Coolers, Water
Everson Filter Co., 647 No. Green St., Chicago, Ill.

Corner Bead Metal
Concrete Steel Co., New York City.

Couplings, Threadless
Geo. H. Snell, Attleboro, Mass.

Couplings, (No Gasket)
Clark Co., H. W., Mattoon, Ill.

Couplings, Yokes (One Piece)
Clark Co., H. W., Mattoon, Ill.

Covers, Manhole
(See Manhole Covers)

Cranes, Crawling Tractor
Harnischfeger Corp., Milwaukee, Wis.
Koehring Company, Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, Ohio.
Thew Shovel Co., Lorain, Ohio.
Universal Crane Co., Lorain, Ohio.

Cranes, Creeper
Industrial Brownhoist Corp., Cleveland.

Cranes, Diesel
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Cranes, Electric
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brownhoist Corp., Cleveland.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.
Thew Shovel Co., Lorain, Ohio.
Universal Crane Co., Lorain, Ohio.

Cranes, Gasoline
Buckeye Traction Ditcher Co., Findlay, Ohio.
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brownhoist Corp., Cleveland.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.
Ohio Power Shovel Co., Lima, O.
Thew Shovel Co., Lorain, O.

Cranes, Jib
Harnischfeger Corp., Milwaukee, Wis.

Cranes, Locomotive
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Bay City Foundry & Machine Co., Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Byers Mch. Co., Ravenna, O.
Harnischfeger Corp., Milwaukee, Wis.
Insley Mfg. Co., Indianapolis, Ind.
Industrial Brownhoist Corp., Cleveland.
Koehring Co., Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.
Orton Crane & Shovel Co., Chicago.
Osgood Company, Marion, O.
Speeder Machinery Co., Cedar Rapids, Ia.
Thew Shovel Co., Lorain, O.
Trackson Co., 533 Clinton St., Milwaukee.
Universal Crane Co., Lorain, O.

Cranes, Motor-Truck
Bay City Foundry & Machine Co., Bay City, Mich.
Byers Mch. Co., Ravenna, O.
Orton Crane & Shovel Co., Chicago, Ill.
Harnischfeger Corp., Milwaukee, Wis.
Universal Crane Co., Lorain, O.

Cranes, Overhead
Harnischfeger Corp., Milwaukee, Wis.

Cranes, Repair
Fulton Iron Works Co., St. Louis, Mo.

Cranes, Revolving
Page Engineering Co., Chicago, Ill.

Cranes, Road
Bucyrus-Erie Co., Erie, Pa.
The Byers Machine Co., Ravenna, O.

Cranes, Shovels
Manitowoc Engineering Wks., Manitowoc, Wis.

Cranes, Steam
Industrial Brownhoist Corp., Cleveland.
Thew Shovel Co., Lorain, O.

Cranes, Traveling
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brown Hoisting Co., Cleveland, O.
Speeder Machinery Corp., Cedar Rapids, Ia.

Cranes, Wrecking
Industrial Brown Hoisting Co., Cleveland, O.

Crawler Attachments
Haiss Mfg. Co., Inc., Geo., New York City.
Trackson Co., 533 Clinton St., Milwaukee, Wis.

Crimpers, Cap
E. I. DuPont de Nemours & Co., Wilmington, Del.

Crushers and Pulverizers
Allis-Chalmers Mfg. Co., Milwaukee.
Austin Western Rd. Mchy. Co., Chicago.
Bakstad Crusher & Equipment Corp., 122 S. Michigan Ave., Chicago, Ill.
Bay City Fdry. & Mch. Co., Bay City, Mich.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Iowa Manufacturing Co., Cedar Rapids, Ia.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Universal Road Machinery Co., Kingston, N. Y.
Wheeling Mold. & Fdy. Co., Wheeling, W. Va.
Western Wheeled Scraper Co., Aurora, Ill.

Crushers, Gyratory
Allis-Chalmers Mfg. Co., Milwaukee.
Austin Western Road Mach. Co., Chicago, Ill.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Crushers, Portable, with Elevator and Screens
Bakstad Crusher & Equipment Corp., 122 S. Michigan Ave., Chicago, Ill.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Iowa Manufacturing Co., Cedar Rapids, Ia.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.
Universal Road Machinery Co., Kingston, N. Y.

Crushers, Rock
Allis-Chalmers Mfg. Co., Milwaukee.
Austin Western Road Machinery Co., Chicago, Ill.
Bakstad Crusher & Equipment Corp., 122 S. Michigan Ave., Chicago, Ill.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Gruendler Patent Crusher & Pulverizer Co., St. Louis, Mo.
Iowa Mfg. Co., Cedar Rapids, Ia.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Universal Road Machinery Co., Kingston, N. Y.
Western Wheeled Scraper Co., Aurora, Ill.

Crushers, Repairs
Fulton Iron Works Co., St. Louis, Mo.

Culverts, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.

Culverts, Corrugated
American Casting Co., Birmingham.
Armco Culvert Mfrs. Assn., Middletown, O.
Gallon Iron Works, Gallon, O.
Toncan Culvert Mfrs.' Assn., Massilon, O.

Culverts, Metal
Armco Culvert & Flume Mfrs. Assn., Middletown, O.
Austin Western Rd. Mchy. Co., Chicago.
U. S. Cast Iron Pipe & Fdy. Co., Birmingham, Ala.
R. D. Wood & Co., Philadelphia, Pa.

Culverts, Nestable & Riveted, Corrugated
Armco Culvert Mfrs. Assn., Middletown, O.
Toncan Culvert Mfrs.' Assn., Massillon, O.

Culvert Stock, Copper Alloy
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.

Culverts
American Casting Co., Birmingham.
Burch Corporation, Crestline, Ohio.
Cast Iron Pipe Research Bureau, Chicago, Ill.
Gallon Iron Works & Mfg. Co., Gallon, Ohio.
Good Roads Mchy. Co., Inc., Kennett Square, Pa.
Klauer Mfg. Co., Dubuque, Ia.
Lock Joint Pipe Co., Ampere, N. J.
U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.
Wheeling Mold & Foundry Co., Wheeling, W. Va.

Cups, Suction & Force
Coleman, Allan, Chicago, Ill.

Curb Boxes
H. W. Clark Co., Mattoon, Ill.
Mueller Company, Decatur, Ill.
Reading Meter Repair Co., Reading, Pa.
S. E. T. Valve & Hydrant Co., New York, N. Y.

Curbs, Steel Protected
Concrete Steel Co., New York City.

Cutter, Gauge Glass
Coleman, Allan, Chicago, Ill.

Cutters, Asphalt
Chicago Pneumatic Tool Co., New York, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Dam Proofing
Philip Carey Company, Cincinnati, O.
Ceresit Waterproofing Co., Chicago, Ill.

Derrick Swingers
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Lidgerwood Mfg. Co., Elizabeth, N. J.

Derricks and Derrick Fittings
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Byers Mch. Co., Ravenna, Ohio.
Clyde Iron Works, Sales Co., Duluth, Minn.
Harnischfeger Corp., Milwaukee, Wis.
Hayward Co., New York City, N. Y.
Industrial Brown Hoisting Corp., Cleveland, O.
Insley Mfg. Co., Indianapolis, Ind.
Lidgerwood Mfg. Co., Elizabeth, N. J.

Diamond Floor Plates
Wood Steel Co., Allan, Conshohocken, Pa.

Diesel Engines
Chicago Pneumatic Tool Co., New York City.
Fairbanks-Morse & Co., Chicago.

Diggers, Trench and Clay
Chicago Pneumatic Tool Co., New York City.
Ingersoll-Rand Co., New York City.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Diggers, Pneumatic
Chicago Pneumatic Tool Co., New York City.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.

Diggers, Post Hole
Buda Company, Harvey, Ill.

Diggers, Trench
Buckeye Traction Ditcher Co., Findlay, Ohio.

Dip, Sewer & Basin
Coleman, Allan, Chicago, Ill.

Dipper Teeth
Western Crucible Steel Castings Co., Minneapolis, Minn.

Distributors, Pressure Oil
(See Road Oilers, Pressure)

Ditchers, Railway
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Industrial Brown Hoisting Corp., Cleveland, Ohio.
The Marion Steam Shovel Co., Marion, Ohio.

Ditching Machinery
(See Excavators.)

Dock Loading Machinery
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Drafting Machines
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.

Draglines
Bucyrus-Erie Company, Erie, Pa.
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brownhoist Corp., Cleveland.
Koehring Company, Milwaukee, Wis.
Marion Steam Shovel Co., Marion, O.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.
Thew Shovel Co., Lorain, O.
Universal Crane Co., Lorain, O.

Drags, Road
J. D. Adams Co., Indianapolis, Ind.
Burch Corporation, Crestline, O.
Klauer Mfg. Co., Dubuque, Ia.
Western Wheeled Scraper Co., Aurora, Ill.

Drain Pipe
Armco Culvert Mfrs. Assn., Middletown, O.

Drain Traps
Clark Co., H. W., Mattoon, Ill.

Drainers, Cellar
The Economy Pumping Machy. Co., Chicago, Ill.

Drains, Perforated Iron
Armco Culvert Mfg. Assn., Middletown, Ohio.

Drawing Materials
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.

Drawing Tables
(See Tables and Bds. Drg.)

CLASSIFIED INDEX OF PRODUCTS

Dredges
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Hayward Co., New York, N. Y.
Industrial Brown Hoisting Corp., Cleveland, O.
Lidgerwood Mfg. Co., Elizabeth, N. J.
The Marion Steam Shovel Co., Marion, Ohio.
Norborn Engineering Co., Darby, Pa.
Osgood Company, Marion, Ohio.

Dredges, Dipper
Bucyrus-Erie Company, Erie, Pa.
Erie Steam Shovel Co., Erie, Pa.
Harnischfeger Corp., Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Osgood Company, Marion, Ohio.

Dredges, Hydraulic
Bucyrus-Erie Company, Erie, Pa.
Marion Steam Shovel Co., Marion, O.
The Norborn Engineering Co., Darby, Pa.

Drill Column & Mountings
Ingersoll-Rand Co., New York, N. Y.

Drilling, Contractors' Test
Sullivan Mach. Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Air
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Air Hammer
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Blasthole
Buda Company, Harvey, Ill.

Drills, Core
Ingersoll-Rand Co., New York City.
Keystone Driller Co., Beaver Falls, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Concrete
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Diamond Core Prospecting
Sullivan Mach. Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Earth
Buda Company, Harvey, Ill.
Schramm, Inc., West Chester, Pa.

Drills, Earth—Fence Post
Buda Company, Harvey, Ill.

Drills, Pavement, Core Test
Sullivan Machy. Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Posthole
Buda Company, Harvey, Ill.

Drills, Prospecting
Ingersoll-Rand Co., New York, N. Y.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drills, Railway Track
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Drills, Rock
Chicago Pneumatic Tool Co., New York City.
Ingersoll-Rand Co., New York City.
O. K. Clutch & Machy. Co., Columbia, Pa.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drill Sharpeners
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drill Steel, Furnaces
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drill Steel, Rock
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Drums, Counterweight
Hayward Co., New York City.

Drums, Holding
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Hayward Co., New York City.

Dry Chemical Feed Machines
Bacharach & Co., E. W., Kansas City, Mo.

Dryers
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Dryers, Sand, Portable
Aeroil Burner Co., Inc., West New York, N. J.
Connery & Co., Inc., 3996 N Second St., Philadelphia, Pa.
Jos. Honhorst Company, Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Dump Bodies
Anthony Co., Streator, Ill.
Hercules Products Co., Evansville, Ind.
Hughes-Keenan C., Mansfield, O.
Lee Trailer & Body Co., Plymouth, Ind.
Wood Hydraulic Hoist & Body Co., Detroit, Mich.

Dump Wagons
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Mchy. Co., Chicago.

Dust Control
The Barrett Co., New York, N. Y.
Dow Chemical Co., Midland, Mich.
Standard Oil Company, of Ind., Chicago, Ill.
Standard Oil Co. of N. Y., New York.
The Texas Company, New York, N. Y.

Dynamite
E. I. DuPont de Nemours & Co., Wilmington, Del.

Eaves, Trough
Klauer Mfg. Co., Dubuque, Ia.

Electric Display Fixtures
Everson Filter Co., 647 No. Green St., Chicago, Ill.

Elevators
Geo. Haiss Mfg. Co., Inc., New York.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Elevators, Bucket
Austin Western Rd. Mchy. Co., Chicago.
Haiss Mfg. Co., Inc., Geo., New York.
Industrial Brownhoist Corp., Cleveland.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Universal Road Machinery Co., Kingston, N. Y.

Elevators, Contractors' Material
Austin Western Rd. Mchy. Co., Chicago.
Byers Mch. Co., Ravenna, O.
Domestic Engine & Pump Co., Shippenburg, Pa.
Dravo Equipment Co., Pittsburgh.
Insley Mfg. Co., Indianapolis, Ind.
Ransome Concrete Mchry. Co., Dunnellen, N. J.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Elevators, Contractor Portable
O. K. Clutch & Machy. Co., Columbia, Pa.

Engineering Instruments
Buff & Buff Mfg. Co., Jamaica Plain, Mass.
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.

Engineers
(See Directory of Engineers.)
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Engineers' and Draftsmen's Instruments and Supplies
Kern Company, New York City.

Engines, Corliss
Fulton Iron Works Co., St. Louis, Mo.

Engines, Deep Well Pumping
American Well Works, Aurora, Ill.

Engines, Derrick Swinging
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.

Engines, Diesel
Allis-Chalmers Mfg. Co., Milwaukee.
Chicago Pneumatic Tool Co., New York.
Fairbanks Morse & Co., Chicago, Ill.
Fulton Iron Works Co., St. Louis, Mo.
Hercules Motors Corp., Canton, O.

Engines, Gas, Gasoline & Oil
Allis-Chalmers Mfg. Co., Milwaukee.
Buda Co., Harvey, Ill.
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Chicago Pneumatic Tool Co., New York.
Climax Engineering Co., Clinton, Ia.
Domestic Engine & Pump Co., Shippenburg, Pa.
Electric Wheel Co., Quincy, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Fulton Iron Works Co., St. Louis, Mo.
Ingersoll-Rand Co., New York, N. Y.
Novo Engine Co., 220 Porter St., Lansing, Mich.
Waukesha Motor Co., Waukesha, Wis.

Engines, Hoisting
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Clyde Iron Works Sales Co., Duluth, Minn.
Fairbanks Morse & Co., Chicago, Ill.

Engines, Kerosene
Chicago Pneumatic Tool Co., New York, N. Y.
International Harvester Co., of America, Chicago, Ill.

Engines, Oil
Allis-Chalmers Mfg. Co., Milwaukee.
Chicago Pneumatic Tool Co., New York, N. Y.
Fairbanks Morse & Co., Chicago, Ill.
Fulton Iron Works Co., St. Louis, Mo.
Ingersoll-Rand Co., New York, N. Y.

Engines, Portable
Novo Engine Co., 220 Porter St., Lansing, Mich.

Engines, Steam
Industrial Brownhoist Corp., Cleveland, Ohio.
Orr & Sembower, Reading, Pa.
Universal Road Machinery Co., Kingston, N. Y.

Engines, Steam Portable
Allis-Chalmers Mfg. Co., Milwaukee.

Equipment, Chlorine Control
Wallace & Tiernan, Newark, N. J.

Evaporators, Vacuum
Manistee Iron Works Co., Manistee, Mich.

Excavators, Bucket
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Co., Erie, Pa.
Byers Machine Co., Ravenna, O.
Keystone Driller Co., Beaver Falls, Pa.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
The Marion Steam Shovel Co., Marion, Ohio.
Orton Crane & Shovel Co., Chicago, Ill.
The Thew Shovel Co., Lorain, O.

Excavator, Cableway
Lidgerwood Mfg. Co., Elizabeth, N. J.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Excavators, Crane
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Byers Machine Co., Ravenna, O.
The General Excavators Co., Marion, Ohio.
Industrial Brown Hoisting Corporation, Cleveland, O.
Koehring Company, Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
The Marion Steam Shovel Co., Marion, Ohio.
Orton Crane & Shovel Co., Chicago, Ill.
Speeder Machinery Corp., Cedar Rapids, Ia.
Thew Shovel Co., Lorain, O.
Universal Crane Company, Lorain, O.

Excavators, Curb
Buckeye Traction Ditcher Co., Findlay, Ohio.

Excavators, Ditch and Trench
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
The Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Byers Mch. Co., Ravenna, O.
Harnischfeger Corp., Milwaukee, Wis.
Hayward Co., New York, N. Y.
Industrial Brown Hoisting Corp., Cleveland, O.
Keystone Driller Co., Beaver Falls, Pa.
Koehring Company, Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.
Orton Crane & Shovel Co., Chicago, Ill.
Osgood Company, Marion, Ohio.
Thew Shovel Co., Lorain, O.
Universal Crane Co., Lorain, O.

Excavators, Dragline
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Byers Mch. Co., Ravenna, O.
The General Excavator Co., Marion, O.
Harnischfeger Corp., Milwaukee, Wis.
Hayward Co., New York City.
Industrial Brownhoist Corp., Cleveland.
Koehring Company, Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, Ohio.
Orton Crane & Shovel Co., Chicago, Ill.
Osgood Company, Marion, Ohio.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.
Speeder Machinery Corp., Cedar Rapids, Ia.
Thew Shovel Co., Lorain, O.
Universal Crane Co., Lorain, O.

Excavators, Power
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
The Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Byers Machine Co., Ravenna, O.
The General Excavators Co., Marion, Ohio.
Haiss Mfg. Co., Geo., New York City.
Industrial Brown Hoisting Corp., Cleveland, Ohio.
Keystone Driller Co., Beaver Falls, Pa.
Koehring Co., Milwaukee, Wis.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
The Marion Steam Shovel Co., Marion, Ohio.
Orton Crane & Shovel Co., Chicago, Ill.
Speeder Machinery Corp., Cedar Rapids, Ia.
The Thew Shovel Co., Lorain, O.
Universal Crane Co., Lorain, O.

Expanded Metal
Concrete Steel Co., New York City.
Ryerson & Son, Jos. T., Chicago, Ill.
Truscon Steel Co., Youngstown, Ohio.

Expansion Joints
Servicised Products Corp., Chicago, Ill.
Philip Carey Co., Cincinnati, O.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Explosives
E. I. DuPont de Nemours & Co., Wilmington, Del.

Fabric, Steel Reinforcing
American Steel & Wire Co., Chicago.
National Steel Fabric Co., Pittsburgh.
Joseph T. Ryerson & Son, Inc., Chicago, Ill.

Feed, Chemical
Wallace & Tiernan, Newark, N. J.

Feeders, Chemical
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Wallace & Tiernan, Newark, N. J.

Felt, Tarred
American Tar Products Corp., Pittsburgh, Pa.

Fence, Highway
American Steel & Wire Co., Chicago.
American Wire Fence Co., Chicago, Ill.
Page Steel & Wire Co., Bridgeport, Conn.
John A. Roebling's Sons Co., Trenton, N. J.
Wickwire Spencer Steel Co., New York.
Williamsport Wire Rope Co., Williamsport, Pa.

Fiber Sweeping Machines
Huntsville Fiber & Veneer Wks., Huntsville, Ala.

Filler, Asphalt
Philip Carey Co., Cincinnati, Ohio.
Kentucky Rock Asphalt Co., Louisville.
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co., of New York, New York, N. Y.
The Texas Company, New York, N. Y.

Fillers, Bituminous
American Tar Products Corp., Pittsburgh, Pa.
The Barrett Company, New York, N. Y.
Kentucky Rock Asphalt Co., Louisville.
Standard Oil Company of Indiana, Chicago, Ill.
Standard Oil Co. of New York, New York, N. Y.
Servicised Products Corp., Chicago, Ill.
The Texas Co., New York City.

Filtering Equipment
Bacharach & Co., E. W., Kansas City, Mo.
Everson Filter Co., 647 No. Green St., Chicago, Ill.

Filtering Systems
Bacharach & Co., E. W., Kansas City, Mo.
Everson Filter Co., 647 N. Green St., Chicago, Ill.

Filters, Water, Municipal and Industrial
Bacharach & Co., E. W., Kansas City, Mo.
Norwood Eng. Co., Florence, Mass.

Filter Agents
The Columbia Silica Co., 38 So. Dearborn St., Chicago, Ill.
Tamms Silica Co., Chicago.

Finishers, Bridges
Roughan Paving Gauge Co., Fond Du Lac., Wis.

Finishing Machines
A. W. French & Co., Chicago, Ill.
Heltzel Steel Form & Iron Co., Warren, O.

Fire Escapes
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Fireproofing Material & Construction
Concrete Steel Co., New York City.

Fish Traps
R. D. Wood & Co., Philadelphia, Pa.

Fittings
Crane Co., Chicago, Ill.

Fixtures, Electric Display
Everson Filter Co., 647 N. Green St., Chicago, Ill.

Fittings, Pipe Heavy
Fulton Iron Works Co., St. Louis, Mo.
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.

Fittings, Cast Iron
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Fixtures for Overhead Tanks, Stand Pipe or Water Crane Work
Fairbanks, Morse & Co., Chicago, Ill.

Floats, Rotary
Heltzel Steel Form & Iron Co., Warren, O.

CLASSIFIED INDEX OF PRODUCTS

Floor, Asphalt Mastic
Standard Oil Co. of Indiana, Chicago.
Standard Oil Co. of N. Y., New York City.

Floor Finish
Ceresit Waterproofing Co., Chicago, Ill.

Floor Hardener, Concrete
(See Conc. Floor Hardener.)

Floor Plates
Central Iron & Steel Co., Harrisburg.
Wood Steel Co., Alan, Conshohocken. Pa.

Flooring, Fireproof
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Wood Steel Co., Alan, Conshohocken, Pa.

Flue Lining
Clay Products Assn., Chicago, Ill.

Flumes, Iron & Steel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Klauer Mfg. Co., Dubuque, Ia.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Flush Tank, Syphons
Pacific Flush Tank Co., New York,

Flushers Hydraulic Sewer
Coleman, Allan, Chicago, Ill.
Peterson's Hydraulic Sewer Flusher Co., Milwaukee, Wis.

Flushers, Street
E. D. Entyre & Co., Inc., 63 Jefferson St., Oregon, Ill.

Fordson Attachments
Trackscon Co., Milwaukee, Wis.

Fordson Hoist Mountings
Clyde Iron Works Sales Co., Duluth.

Forges, Oil & Coke, Drill Steel
Ingersoll-Rand Co., New York, N. Y.

Forgings
Carnegie Steel Co., Pittsburgh, Pa.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Form Clamps
Insley Mfg. Co., Indianapolis, Ind.

Form Tighteners
Robert Bosch Mag. Co., Long Island City, N. Y.

Formgraders
Ted Carr Co., Chicago.

Forms, Concrete for Meter Boxes and Valve Housings
Clark Co., H. W., Mattoon, Ill.

Forms, Concrete Manhole
Clark Co., H. W., Mattoon, Ill.
Metal Forms Corp., Milwaukee, Wis.

Forms, for Concrete Meter Boxes
Clark Co., H. W., Mattoon, Ill.

Forms, Culvert, Road, Sewer, Tunnel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Heltzel Steel Form & Iron Co., Warren, O.

Forms for Curbs and Gutter
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Forms, Road & Sidewalk, Curb & Gutter
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Heltzel Steel Form & Iron Co., Warren, O.
Metal Forms Corp., Milwaukee, Wis.

Forms for Walls, Building Construction, etc.
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Metal Forms, Milwaukee, Wis.

Forms, Wood
National Lumber Mfrs. Assn., Washington, D. C.

Foundry Products, Misc.
Cast Iron Pipe Research Bureau, Chicago, Ill.
U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Fresnos
Galion Iron Works, Galion, O.

Frogs and Switches, Railway
Sweets Steel Co., Williamsport, Pa.

Furnaces, Compound Melting
Hauck Mfg. Co., Brooklyn, N. Y.

Furnaces, Lead Melting
Hauck Mfg. Co., Brooklyn, N. Y.
Jos. Honhorst Co., Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
The Leadite Co., Philadelphia, Pa.
Reading Meter Repair Co., Reading, Pa.

Furnaces, Oil Drill Steel
Ingersoll-Rand Co., New York, N. Y.
Sullivan Machy. Co., Chicago.

Fuse Detonating
E. I. DuPont de Nemours & Co., Wilmington, Del.

Fuse Safety
E. I. DuPont de Nemours & Co., Wilmington, Del.

Galvanometers, Blasting
E. I. DuPont de Nemours & Co., Wilmington, Del.

Garbage Disposal Apparatus
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Garbage Collection Wagons
Lee Trailer & Body Co., Chicago, Ill.

Gas Producers, Automatic
R. D. Wood & Co., Philadelphia.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Gaskets, Proof-Felt, Closet Bowl
Coleman, Allan, Chicago, Ill.

Gates, Bin
Allis-Chalmers Mfg. Co., Milwaukee.
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Butler Bin Co., Waukesha, Wis.
Good Roads Machy. Co., Inc., Kennett Square, Pa.
George Haiss Mfg. Co., Inc., New York, N. Y.
C. S. Johnson, Champaign, Ill.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Gates, Clam Shell
Haiss Mfg. Co., Geo., New York Citv.

Gates, Drainage
Armco Culvert & Flume Mfrs. Assn., Middletown, O.

Gates, Sluice
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.
Columbian Iron Works, Chattanooga.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Gate Valve Housing
Clark Co., H. W., Mattoon, Ill.
Reading Meter Repair Co., Reading, Pa.

Gauges, Depth
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Gauges, Elevated Tank
Clark Co., H. W., Mattoon, Ill.

Gauges, Loss of Head
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Gauges, Paving
Roughan Paving Gauge Co., Fond Du Lac. Wis.

Gauges, Rates of Flow
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Gauges, Recording
Clark Co., H. W., Mattoon, Ill.

Gauges, Surface Reservoir
Clark Co., H. W., Mattoon, Ill.

Gear, Reduction Units
Twin Disc Clutch Co., Racine, Wis.

Gears
Brown Lipe Gear Co., Syracuse, N. Y.
Foote Bros. Gear & Mach., Co., Chicago, Ill.
Haiss Mfg. Co., Geo., New York City.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Gears, Spur
Fulton Iron Works Co., St. Louis, Mo.

Gears, Worm Reduction
De Laval Steam Turbine Co., Trenton, N. J.

Gelatin, Blasting
E. I. DuPont de Nemours & Co., Wilmington, Del.

Generating Sets, Diesel Engine
Fairbanks-Morse & Co., Chicago, Ill.

Generators, Electric
Allis-Chalmers Mfg. Co., Milwaukee.
Bosch Mag. Co., Robert, N. Y. City.
Fairbanks-Morse Co., Chicago, Ill.

Grader Blades
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Mach. Co., Chicago, Ill.
Galion Iron Works, Galion, O.

Graders, Elevating
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Machy. Co., Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Graders, High Lift
Foote Bros. Gear & Mach. Co., Chicago, Ill.

Graders Road
Adams, J. D., Indianapolis, Ind.
Austin Western Rd. Machy. Co., Chicago, Ill.
The Galion Iron Works & Mfg. Co., Galion, O.
Good Rods Machy. Co., Inc., Kennett Square, Pa.
Highway Shoulder Co., Effingham, Ill.
Klauer Mfg. Co., Dubuque, Ia.
W. A. Riddell Co., Bucyrus, O.
Ryan Mfg. Corp., Chicago.
The Wehr Company, Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.

Graders, Road Power
J. D. Adams Co., Indianapolis, Ind.
Austin Mfg. Co., Chicago, Ill.
Galion Iron Works, Galion, O.
Good Roads Machy. Co., Kennett Square, Pa.
W. A. Riddell Co., Bucyrus, O.

Graders, Trail
Ted Carr & Co., Chicago, Ill.

Grapples, Stone
The Byers Machine Co., Ravenna, O.

Gratings, Flooring
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Gratings, Safety
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Gravel Equipment
Iowa Mfg. Co., Cedar Rapids, Ia.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

Gravel Washing Plants
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Grinders, Air & Electric
Chicago Pneumatic Tool Co., New York.

Grinders, Pedestal
Ingersoll-Rand Co., New York, N. Y.

Grinders, Pneumatic Tool
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York, N. Y.

Grizzlies, Rotary & Stationary
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Grouting
American Asphalt Grouting Co., Chattanooga, Tenn.
Dravo Contracting Co., Pittsburgh, Pa.

Guard, Highway
American Wire Fence Co., Chicago, Ill.
Maggart Corp., Chicago, Ill.
Page Steel & Wire Co., Bridgeport, Conn.
Wickwire Spencer Steel Co., New York City, N. Y.
Williamsport Wire Rope Co., Williamsport, Pa.

Gunite Construction
Cement Gun Constr. Co., Chicago.

Hammers, Calking
Chicago Pneumatic Tool Co., New York, N. Y.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Ingersoll-Rand Co., New York.
Schramm, Inc., West Chester, Pa.

Hammers, Chipping
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Hammers, Pile Driver
Industrial Brown-Hoist Corp., Cleveland, O.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Hammers, Riveting
Chicago Pneumatic Tool Co., New York, N. Y.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Haydite—Aggregate
Hydraulic Press Brick Co., St. Louis, Mo.

Head Gates
American Casting Co., Birmingham, Ala.
Klauer Mfg. Co., Dubuque, Ia.

Headwalls
American Casting Co., Birmingham, Alabama.

Heaters, Asphalt Tool
Hauck Mfg. Co., Brooklyn, N. Y.

Heaters, Concrete
Hauck Mfg Co., Brooklyn, N. Y.

Heaters & Dryers—Sand and Gravel
Jos. Honhorst Co., Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Heaters, Pavement Tool
Hauck Mfg. Co., Brooklyn, N. Y.

Heaters, Surface
Hauck Mfg. Co., Brooklyn, N. Y.

Heaters, Tar & Asphalt
Austin Western Machy. Co., Chicago.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
E. D. Entyre & Co., Inc., 63 Jefferson St., Oregon, Ill.
Hauck Mfg. Co., Brooklyn, N. Y.
Jos. Honhorst, Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Mohawk Asphalt Heater Co., Schenectady, N. Y.
Reading Motor Repair Co., Reading, Pa.
The Rightway Corporation, 228 N. La Salle St., Chicago, Ill.

Heaters, Concrete
Aeroil Burner Co., Union City, N. J.
E. D. Entyre & Co., Inc., 63 Jefferson St., Oregon, Ill.
Jos. Honhorst Co., Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Mohawk Asphalt Heater Co., Schenectady, N. Y.
Standard Steel Works, North Kansas City, Mo.

Heaters, Asphalt Tool
Jos. Honhorst Co., Cincinnati, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Heaters, Car
Klauer Mfg. Co., Dubuque, Ia.

Heaters, Pavement Tool
Aeroil Burner Co., Inc., West New York, N. J.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Heaters, Surface
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Heaters, Water
Aeroil Burner Co., Inc., Union Hill, N. J.
Central Foundry Co., New York, N. Y.
Hauck Mfg. Co., Brooklyn, N. Y.

Hemp, Braided
The Leadite Co., Philadelphia, Pa.

Highway Guard, Cable
American Steel & Wire Co., Chicago.
Cleveland Hardware Co., Cleveland, O.
Williamsport Wire Rope Co., Williamsport, Pa.

Highway, Mowers
Rawls Manufacturing Co., 202-210 Iowa Ave., Streator, Ill.

Hoes, Trench
Bucyrus-Erie Co., Erie, Pa.

Hoes, Patching, Asphalt
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Hoisting, Conveying Appliances
Industrial Brownhoist Corporation, Cleveland, O.

Hoists
Clyde Iron Works Sales Co., Duluth.
O. K. Clutch & Machinery Co., Columbia, Pa.
Sullivan Machy. Co., Chicago, Ill.

Hoists, Air Motor
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Hoists, Belt
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.

Hoists, Cableway
Allis-Chalmers Mfg. Co., Milwaukee.
Domestic Engine & Pump Co., Shippensburg, Pa.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Hoists, Concrete Tower
Insley Manufacturing Co., Indianapolis.
Lidgerwood Mfg. Co., Elizabeth, N. J.
O. K. Clutch & Mach. Co., Columbia, Pa.

Hoists, Contractors' Electric
Allis-Chalmers Mfg. Co., Milwaukee.
American Cement Machine Co., 251 E. Fourth St., Keokuk, Ia.
American Hoist & Derrick Co., St. Paul, Minn.
Bay City Dredge Works, Bay City.
Byers Machy. Co., Ravenna, O.
Domestic Engine & Pump Co., Shippensburg, Pa.
Fairbanks, Morse Co., Chicago, Ill.
Harnischfeger Corporation, Milwaukee.
Industrial Brownhoist Corporation, Cleveland, O.
Ingersoll-Rand Co., New York, N. Y.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Novo Engine Co., 220 Porter St., Lansing Mich.
Sullivan Machy. Co., Chicago, Ill.
Wood Hydraulic Hoist & Body Co., Detroit, Mich.

Hoists, Contractors' Gasoline
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Domestic Engine & Pump Co., Shippensburg, Pa.
Harnischfeger Corp., Milwaukee.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Novo Engine Co., 220 Porter St., Lansing, Mich.

CLASSIFIED INDEX OF PRODUCTS

Hoists, Contractors' Steam
Allis-Chalmers Mfg. Co., Milwaukee.
Byers Mch. Co., Ravenna, O.
Ingersoll-Rand Co., New York City.
Lidgerwood Mfg. Co., Elizabeth, N. J.
Orr & Sembower, Reading, Pa.

Hoists, Dragline Scraper
Allis-Chalmers Mfg. Co., Milwaukee.
Domestic Engine & Pump Co., Shippensburg, Pa.
Lidgerwood Mfg. Co., Elizabeth, N. J.
O. K. Clutch & Machy. Co., Columbia, Pa.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.
Sullivan Machy. Co., Chicago, Ill.

Hoists, Electric
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Fairbanks, Morse & Co., Chicago, Ill.
Harnischfeger Corp., Milwaukee, Wis.
Orr & Sembower, Reading, Pa.
Sullivan Machy. Co., Chicago, Ill.

Hoists, Gasoline
Clyde Iron Works, Duluth, Minn.
O. K. Clutch & Machy. Co., Columbia, Pa.
Orr & Sembower, New York.

Hoists, Geared
Allis-Chalmers Mfg. Co., Milwaukee.
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Chicago Pneumatic Tool Co., New York, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
O. K. Clutch & Machy. Co., Columbia, Pa.
Sullivan Machy. Co., Chicago, Ill.

Hoists, Hand
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Anthony Co., Inc., Streator, Ill.
Harnischfeger Corp., Milwaukee, Wis.

Hoists, Hydraulic
The Hughes-Keenan Co., Mansfield, O.
Hydraulic Hoist Mfg. Co., St. Paul.
Wood Hydraulic Hoist & Body Co., Detroit, Mich.

Hoists, Material Tower
O. K. Clutch & Machy. C., Columbia, Pa.

Hoist, Mast
Insley Mfg. Co., Indianapolis, Ind.

Hoists, Motor Truck
Anthony Co., Inc., Streator, Ill.
The Galion Allsteel Body Co., Galion, Ohio.
The Hughes-Keenan Co., Mansfield, O.
Hydraulic Hoist Manufacturing Co., St. Paul, Minn.
Wood Hydraulic Hoist & Body Co., Detroit, Mich.

Hoists, Pneumatic
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York City.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Hoists, Quarry
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Hoists, Scraper, Bucket
Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
O. K. Clutch & Machy. Co., Columbia, Pa.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.
Sullivan Mach. Co., 819 Wrigley Bldg., Chicago, Ill.

Hoists, Scraper Loader
Allis-Chalmers Mfg. Co., Milwaukee.
Ingersoll-Rand Co., New York, N. Y.
O. K. Clutch & Machy. Co., Columbia, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Hoists, Skip
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Holders-on, Riveting
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.

Hoppers, Aggregate Measuring
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Butler Bin Co., Waukesha, Wis.
Geo. Haiss Mfg. Co., Inc., New York.
C. S. Johnson Co., Champaign, Ill.

Hoppers, Cast Iron
Fulton Iron Works, St. Louis, Mo.

Hoppers, Concrete
Insley Manufacturing Co., Indianapolis, Ind.
Ransome Concrete Mchry. Co., Dunnellen, N. J.

Hoppers, Concrete Tower
Ransome Concrete Mchy. Co., Dunellen, N. J.

Hoppers, Steel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Butler Bin Co., Waukesha, Wis.
R. D. Cole Mfg. Co., Newman, Ga.
Johnson Company, C. S., Champaign, Ill.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Hose Clamps
Chicago Pneumatic Tool Co., New York, N. Y.

Hose Couplings
Chicago Pneumatic Tool Co., New York, N. Y.

Hose, Armored
Ingersoll-Rand Co., New York, N. Y.

Hose, Steam, Air, Water
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Hydrants
The Bourbon Copper and Brass Works Co., 618-620 E. Front St., Cincinnati, Ohio.
Columbia Iron Works, Chattanooga, Tenn.
Darling Valve & Mfg. Co., Williamsport, Pa.
Wood & Co., R. D., Philadelphia, Pa.

Hydrants, Fire
The Bourbon Copper and Brass Works Co., 618-620 E. Front St., Cincinnati, Ohio.
Columbian Iron Works, Chattanooga, Tenn.
Fulton Iron Works Co., St. Louis, Mo.
R. D. Wood & Co., Philadelphia, Pa.

Hydrants, Self Closing
The Bourbon Copper and Brass Works Co., 618-620 E. Front St., Cincinnati, Ohio.

Hydraulic Machinery
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Packing
Mabbs Hydraulic Packing Co., Chicago, Ill.

Hydraulic Supplies
Reading Meter Repair Co., Reading, Pa.

Hydrogen Ion Equipment
La Motte Chemical Products Co., Baltimore, Md.

Incinerators
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Indicators (Chemical)
La Motte Chemical Products Co., Baltimore, Md.

Indicator Posts
R. D. Wood & Co., Philadelphia, Pa.

Inlets, Curb
H. W. Clark Company, Mattoon, Ill.
Klauer Mfg. Co., Dubuque, Ia.

Inserts, Concrete
Concrete Steel Co., New York City.

Inspecting Laboratories
(See Directory of Engineers.)

Instruments, Trouble-Finding
Clark Co., H. W., Mattoon, Ill.

Instruments & Drawing Supplies
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.

Instruments, Surveying
Buff & Buff Mfg. Co., Jamaica Plain, Boston, Mass.
Kern Company, New York City.

Inundators for Constant Concrete
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Irons, Branding
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.

Iron Works, Ornamental
The Hughes-Keenan Co., Mansfield, O.

Jacks, Pumping, Geared
American Manganese Bronze Co., Philadelphia, Pa.
American Well Works, Aurora, Ill.
Fairbanks Morse & Co., Chicago, Ill.

Joints, Expansion, Paving
W. R. Meadows, Elgin, Ill.
Servicized Products Corp., Chicago, Ill.

Joints, Filler Paving
Standard Oil Co. of Indiana, Chicago.
Standard Oil Co. of N. Y., New York.

Joints, Flexible Pipe
Central Foundry Co., New York City.
Geo. H. Snell, Attleboro, Mass.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Joint Installer
Roughan Pav. Gauge Co., Fond Du Lac, Wis.

Joists, Steel
Jos. T. Ryerson & Son, Inc., Chicago.

Kettles, Asphalt
Aeroil Burner Co., Inc., Union Hill, N. J.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Good Roads Mchy. Co., Inc., Kennett Square, Pa.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Kettles, Heating, Asphalt & Tar
Aeroil Burner Co., Inc., Union Hill, N. J.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Good Roads Mchy. Co., Inc., Kennett Square, Pa.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Universal Road Mchy. Co., Kingston, N. Y.

Kettles, Master
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.

Kettles, Pouring
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Kettles, Roofing
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Ladder Steps, Steel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Ladles, Metal
H. W. Clark Company, Mattoon, Ill.
Reading Meter Repair Co., Reading, Pa.
The Leadite Company, Philadelphia, Pa.

Lanterns
Dietz Co., R. E., New York City.

Lath, Expanded Metal
Armco Culvert & Flume Mfrs. Assn., Middletown, O.
Concrete Steel Co., New York City.
Ryerson & Son, Jos. T., Chicago, Ill.

Leadite
Leadite Company, Philadelphia, Pa.

Leadite Melting Furnaces
Hauck Mfg. Co., Brooklyn, N. Y.

Lights, Contractors'
McCloskey Torch Co., Toledo, Ohio.
Toledo Pressed Steel Co., Toledo, O.

Lighting Plants, Contractors
Fairbanks Morse & Co., Chicago, Ill.

Loaders, Box Car
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.

Loaders, Buckets
Haiss Mfg. Co., Inc., Geo., New York.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
Trackson Co., 533 Clinton St., Milwaukee, Wis.

Loaders, Car and Wagon
Austin Western Rd. Mchy. Co., Chicago.
Barber-Greene Co., Aurora, Ill.
Burch Corp., Crestline, O.
Haiss Mfg. Co., Inc., Geo., New York.
Heltzel Steel Form & Iron Co., Warren, O.
Industrial Brownhoist Corp., Cleveland, Ohio.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
Trackson Co., 533 Clinton St., Milwaukee, Wis.

Loaders, Coal
Atlas Engineering Co., Clintonville, Wis.
Central Foundry Co., New York, N. Y.
Geo. Haiss Mfg. Co., Inc., New York.

Loaders, Gravel & Sand
Atlas Engineering Co., Clintonville, Wis.
Geo. Haiss Mfg. Co., Inc., New York.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.

Loaders, Portable
Atlas Engineering Co., Clintonville, Wis.
Bay City Dredge Works, Bay City, Mich.
Burch Corporation, Crestline, O.
Haiss Mfg. Co., Geo., New York City.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn.

Loaders, Snow
Bay City Dredge Works, Bay City, Mich.
Haiss Mfg. Co., Inc., Geo., New York City, N. Y.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
The Rightway Corporation, 228 N. La Salle St., Chicago, Ill.

Loaders, Truck
Atlas Engineering Co., Clintonville, Wis.
Bay City Dredge Works, Bay City, Mich.
Haiss Mfg. Co., Inc., Geo., New York City.
Heltzel Steel Form & Iron Co., Warren, O.
N. P. Nelson Iron Works, 821 Bloomfield Ave., Passaic, N. J.
Trackson Co., 533 Clinton St., Milwaukee, Wis.

Log Loaders
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
The Marion Steam Shovel Co., Marion, Ohio.

Logging Machinery
Lidgerwood Mfg. Co., New York, N. Y.

Lubricants
Standard Oil Co. of Ind., Chicago.
Standard Oil Co. of N. Y., New York.

Lumber, Creosoting
National Lumber Mfrs. Assn., Washington, D. C.

Lumber
National Lumber Mfrs. Assn., Washington, D. C.

Machinists, Contracting
Fulton Iron Works Co., St. Louis, Mo.

Machinery from Specall Designs and Machine Work to Order
Fulton Iron Works Co., St. Louis, Mo.

Magazines, Powder
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Magnetos
American Bosch Magneto Corp., Chicago.
Robert Bosch Mag. Co., Long Island City, N. Y.
Eisemann Magneto Co., New York City.

Maintainer, Road
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Mchy. Co., Chicago.
The Huber Mfg. Co., Marion, O.
The Hughes-Keenan Co., Mansfield, O.
The Wehr Company, Milwaukee, Wis.

Manhole Covers
Central Foundry Co., New York City.
H. W. Clark Company, Mattoon, Ill.
Wm. E. Dee Clay Mfg. Co., Chicago.
Fulton Iron Works Co., St. Louis, Mo.
Klauer Mfg. Co., Dubuque, Ia.
Reading Meter Repair Co., Reading, Pa.
South Bend Fdy. & Mach. Co., South Bend, Ind.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Manifolds, Rock Drill
Ingersoll-Rand Co., New York, N. Y.

Manilla Rope
(See Rope, Manilla.)

Manometers
Republic Flow Meter Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Marble & Slate Work
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.

Measuring, Pavement Roughness, Instrument
J. D. Adams Co., Indianapolis, Ind.

Mesh, Reinforcing Concrete
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.

Meter Accessories
Badger Meter Mfg. Co., Milwaukee.
H. W. Clark Co., Mattoon, Ill.
Ford Meter Box Co., Wabash, Ind.

Meter Boxes
H. W. Clark Co., Mattoon, Ill.
Ford Meter Box Co., Wabash, Ind.
Reading Meter Repair Co., Reading, Pa.

Meter Connections
Geo. H. Snell, Attleboro, Mass.

Meter Housing
Clark Co., H. W., Mattoon, Ill.
Reading Meter Repair Co., Reading, Pa.

Meter Testers
H. W. Clark Co., Mattoon, Ill.

Meter Washers, Rawhide
Mabbs Hydraulic Packing Co., Chicago, Ill.

Meters, Jet
Badger Meter Mfg. Co., Milwaukee, Wis.

Meters, Oil
Badger Meter Mfg. Co., Milwaukee, Wis.
Republic Flow Meters Co., Chicago, Ill.

Meters, Pitot Tube
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Meter Repairs
Reading Meter Repair Co., Reading, Pa.

Meters, Sewage
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

CLASSIFIED INDEX OF PRODUCTS

Meters, Sewage (Venturi)
Simplex Valve & Meter Co., Philadelphia, Pa.

Meters, Venturi
Republic Flow Meters Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Meters, Water
Badger Meter Mfg. Co., Milwaukee, Wis.
Republic Flow Meter Co., Chicago, Ill.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Mixers, Asphalt
(See Mixers, Hot.)

Mixers, Concrete
American Cement Machine Co., 251 E. Fourth St., Keokuk, Ia.
Atlas Engineering Co., Clintonville, Wis.
Jaeger Machine Co., 222 Dublin Ave., Columbus, O.
Knickerbocker Co., Jackson, Mich.
Koehring Co., Milwaukee, Wis.
Orr & Sembower, Reading, Pa.
Ransome Concrete Mchy. Co., Dunellen, N. J.
The T. L. Smith Co., 1031 32nd St., Milwaukee, Wis.

Mixers, Grout
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Ransome Concrete Mchy. Co., Dunellen, N. J.
Smith Co., T. L. The, 1031 32nd St., Milwaukee, Wis.

Mixers, Chemical
The Dorr Co., New York City.

Mixers, Mortar
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Jaeger Machine Co., 222 Dublin Ave., Columbus, O.
Knickerbocker Co., Jackson, Mich.
Ransome Concrete Mchy. Co., Dunellen, N. J.
Smith Co., T. L. The, 1031 32nd St., Milwaukee, Wis.

Mixers, Paving
American Cement Machine Co., 251 E. Fourth St., Keokuk, Ia.
Construction Mchy. Co., Waterloo, Ia.
Jaeger Machine Co., 222 Dublin Ave., Columbus, O.
Koehring Company, Milwaukee, Wis.
Ransome Concrete Mchy. Co., Dunellen, N. J.
Smith Co., T. L. The, 1031 32nd St., Milwaukee, Wis.

Mixers, Pneumatic
Ransome Concrete Mchy. Co., Dunellen, N. J.

Mixer, Trailer
Lansing Co., Lansing, Mich.

Motors, Air
Ingersoll-Rand Co., New York, N. Y.

Motors, Centrifugal, Pump
Allis-Chalmers Mfg. Co., Milwaukee.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee.
Fairbanks, Morse & Co., Chicago, Ill.
Stearns Motor Mfg. Co., Ludington, Mich.

Motors, Gasoline
Buda Company, Harvey, Ill.
Climax Engineering Co., Clinton, Ia.
Continental Motors Corp., Muskegon, Mich.
Electric Wheel Co., Quincy, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Hercules Motors Corporation, Canton, Ohio.
Ingersoll-Rand Co., New York, N. Y.
Le Roi Company, Milwaukee, Wis.
Novo Engine Co., 220 Porter St., Lansing, Mich.
Waukesha Motor Co., Waukesha, Wis.
Wisconsin Motor Mfg. Co., Milwaukee.

Motor Truck Accessories
Anthony Co., Inc., Streator, Ill.

Mountings, Truck Rubber Tires
Electric Wheel Co., Quincy, Ill.

Nozzles, Sewage
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.

Motor Trucks
(See Trucks, Motor.)

Mowers, Highway
Rawls Manufacturing Co., 202-210 Iowa Ave., Streator, Ill.

Oils, Road
American Tar Products Co., Pittsburgh, Pa.
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. of New York, New York, N. Y.
The Barrett Company, New York, N. Y.
The Texas Company, New York, N. Y.

Oilers, Road Pressure
Austin Western Rd. Mchy. Co., Chicago, Ill.
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.

Oilers, Rock Drill
Ingersoll-Rand Co., New York, N. Y.

Oils, Building
American Tar Products Corp., Pittsburgh, Pa.

Oils, Creosote
American Tar Products Corp., Pittsburgh, Pa.
Barrett Company, The, New York, N. Y.

Packing, Rawhide
Mabbs Hydraulic Packing Co., Chicago.

Paints—Industrial
Sement-Solvay Co., 61 Broadway, New York, N. Y.

Paint, Traffic
The Barrett Company, New York, N. Y.
Servicised Products Corp., Chicago, Ill.

Patch, Cold, Bit
American Tar Products Corp., Pittsburgh, Pa.
The Barrett Co., New York, N. Y.
Kentucky Rock Asphalt Co., Louisville.
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. or N. Y., New York.
The Texas Company, New York, N. Y.

Patchers, Asphalt, Surface
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Pavements, Bituminous
American Tar Products Corp., Pittsburgh, Pa.
The Barrett Co., New York, N. Y.
Kentucky Rock Asphalt Co., Louisville.
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. of New York, New York, N. Y.
The Texas Company, New York, N. Y.

Pavers
Foote Co., Nunda, N. Y.
Ransome Concrete Mchy. Co., Dunellen, N. J.
Smith Co., T. L. The, 1031 32nd St., Milwaukee, Wis.

Pavement Breakers
Chicago Pneumatic Tool Co., New York City.
Ingersoll-Rand Co., New York City.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Pavement Drills
Sullivan Mchy. Co., Chicago, Ill.

Paving, Asphalt
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. of N. Y., New York.

Paving Blocks, Creosoted Wood
(See Creosoted Block Timber.)

Paving, Brick
National Paving Brick Mfrs. Assn., Chicago.

Paving, Cold Patching
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. N. Y., New York.

Paving Materials, Vitrified Brick
National Paving Brick Mfrs. Assn., Chicago, Ill.

Penstocks
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
R. D. Cole Mfg., Co. Newman, Ga.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.

Pile Drivers
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Harnischfeger Corporation, Milwaukee.
Industrial Brownhoist Corp., Cleveland.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Pile Hammers, Steam
Industrial Brownhoist Corp., Cleveland, Ohio.

Piles, Screw
U. S. Cast Iron Pipe Fdy. Co., Burlington, N. J.

Piling, Steel Sheet
Carnegie Steel Co., Pittsburgh, Pa.
Wemlinger, Inc., New York City.

Pipe, Cast Iron
American Cast Iron Pipe Co., Birmingham, Ala.
Cast Iron Research Assn., Chicago.
Central Foundry Co., New York City.
Clow & Sons, James B., 201-299 N. Talman Ave., Chicago, Ill.
Copper and Brass Research Assn., New York City.
Fulton Iron Works Co. St. Louis, Mo.
McWane Cast Iron Pipe Co., Birmingham, Ala.
National Cast Iron Pipe Co., Birmingham, Ala.
Pacific States Cast Iron Pipe Co., Provo, Utah.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
Wood & Co., R. D., Philadelphia, Pa.

Pipe, Cast Iron Centrifugal
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Cement Lined
American Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Clay, Vitrified
Clay Products Assn., Chicago, Ill.

Pipe, Concrete
Asphalto-Concrete Corp., 1440 Broadway, New York, N. Y.
Independent Concrete Pipe Co., Indianapolis, Ind.
Lock Joint Pipe Co., Ampere, N. J.

Pipe, Conductor
Klauer Mfg. Co., Dubuque, Ia.
Wheeling Mold & Fdy. Co., Wheeling, W. Va.

Pipe Connections
Amer. Cast Iron Pipe Co., Birmingham.
Mueller Co., Decatur, Ill.
U. S. Cast Iron Pipe & Fry. Co., Burlington, N. J.

Pipe, Corrugated
Austin Western Rd. Mchy. Co., Chicago.

Pipe Cutter
Trimont Mfg. Co., Boston, Mass.
Tucker Co., Inc., The, 75 Murray St., New York, N. Y.

Pipe, Culvert
American Casting Co., Birmingham.
Independent Concrete Pipe Co., Indianapolis, Ind.
The Galion Iron Works, Galion, O.
Toncan Culvert Mfrs.' Ass'n., Massillon, O.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Pipe Covering (Asphalt)
Philip Carey Co., Cincinnati, O.

Pipe, deLavaud
U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.

Pipe, Drain
American Cast Iron Pipe Co., Birmingham, Ala.
Asphalto-Concrete Corp., 1440 Broadway, New York, N. Y.
Central Foundry Co., New York, N. Y.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Pipe Drilling Machine
Mueller Co., Decatur, Ill.

Pipe Fittings
Amer. Cast Iron Pipe Co., Birmingham.
American Manganese Bronze Co., Philadelphia, Pa.
Central Foundry Co., New York City.
McWane Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe and Fittings, Cast Iron
Amer. Cast Iron Pipe Co., Birmingham.
Cast Iron Pipe Research Bureau, Chicago, Ill.
Central Foundry Co., New York, N. Y.
McWane Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe and Fittings, Flange
National Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe Fusion, Welded
Kern Company, New York City.

Pipe—Gas Stopper
National Cast Iron Pipe Co., Birmingham, Ala.
Safety Gas Main Stopper Co., New York City.

Pipe, Hydraulic
Bourbon Copper and Brass Works Co., 618-620 E. Front St., Cincinnati, O.
Cast Iron Research Bureau, Chicago.
McWane Cast Iron Pipe Co., Birmingham.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Pipe—Independent
Independent Concrete Pipe Co., Indianapolis, Ind.

Pipe, Ingot Iron
Armco Culvert Mfrs. Assn., Middletown, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Pipe Joint Compounds
Leadite Co., Philadelphia, Pa.
Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill. Also 9 Park Place, New York, N. Y.

Pipe Line Specialties
Crane Co., Chicago, Ill.
Reading Meter Repair Co., Reading, Pa.

Pipe Lines, Submerged
Cast Iron Pipe Research Bureau, Chicago, Ill.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe Locators
Reading Meter Repair Co., Reading, Pa.

Pipe, Lock Joint
Lock Joint Pipe Co., Ampere, N. J.

Pipe Opener Chemical Compound
Coleman Allen, Chicago, Ill.

Pipe, Reinforced Concrete
Independent Concrete Pipe Co., Indianapolis, Ind.
Lock Joint Pipe Co., Ampere, N. J.

Pipe, Riveted Steel
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Pipe Seal
(See Pipe Joint Compounds.)

Pipe, Service
Cast Iron Pipe Research Bureau, Chicago, Ill.
Copper & Brass Research Assn., New York, N. Y.
Independent Concrete Pipe Co., Indianapolis, Ind.
McWane Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Sewer
Asphalto-Concrete Corp., 1440 Broadway, New York.
Cast Iron Pipe Research Bureau, Chicago, Ill.
Clay Products Co., Chicago, Ill.
Clow & Sons, James B., 201-299 N. Talman Ave., Chicago, Ill.
Dee Clay Mfg. Co., Wm. C., Chicago.
Independent Concrete Pipe Co., Indianapolis, Ind.
Lock Joint Pipe Co., Ampere, N. J.
Toncan Culvert Mfrs.' Ass'n., Massillon, O.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
Wheeling Mold & Fdy. Co., Wheeling, W. Va.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Spiral
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Pipe, Storm Sewer
Armco Culvert & Flume Ffrs. Assn., Middletown, O.
Independent Concrete Pipe Co., Indianapolis, Ind.
Toncan Culvert Mfrs.' Ass'n., Massillon, O.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Pipe Pushers
H. W. Clark Co., Mattoon, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Water
National Cast Iron Pipe Co., Birmingham, Ala.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.

Piping, Industrial Plant
Cast Iron Pipe Research Bureau, Chicago, Ill.
U. S. Cast Iron Pipe & Fdy. Co., Burlington, N. J.
R. D. Wood & Co., Philadelphia, Pa.

Planers, Subgrade
Koehring Co., Milwaukee, Wis.

Plants Municipal Filtration
Bacharach & Co., Kansas City, Mo.

Plants Chemical Treating
Bacharach & Co., Kansas City, Mo.

Plants, Electric
Kohler Co., Kohler, Wis.

Plaster, Cement
National Steel Fabric Co., Pittsburgh.

Plates, Annealed
Central Iron & Steel Company, Harrisburg, Pa.
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.
Ryerson & Son, Inc., Jos. T., Chicago.
Alan Wood Steel Co., Conshohocken, Pa.

Plates, Cast Iron Manhole
Fulton Iron Works Co., St. Louis, Mo.

Plates, Floor
Alan Wood Steel Co., Conshohocken, Pa.
Central Iron & Steel Co., Harrisburg, Pa.

Plates, Joint
Concrete Steel Co., New York, N. Y.

Plates, Sheared
Alan Wood Steel Co., Conshohocken, Pa.
Central Iron & Steel Co., Harrisburg, Pa.
Inland Steel Co., 38 South Dearborn St., Chicago, Ill
Ryerson & Son, Inc., Jos. T., Chicago, Ill.

Plate Work
Alan Wood Steel Co., Conshohocken, Pa.
Central Iron & Steel Co., Harrisburg, Pa.
R. D. Cole Mfg. Co., Newman, Ga.
Jos. Honhorst Co., Cincinnati, O.
Littleford, Bros., 454 E. Pearl St., Cincinnati, O.

CLASSIFIED INDEX OF PRODUCTS

Plows, Grading
Adams Co., J. D., Indianapolis, Ind.
Austin Western Rd. Mchy. Co., Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Plows, Rooter
Adams Co., J. D., Indianapolis, Ind.
Austin Western Rd. Mchy. Co., Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.
W. A. Riddell Co., Bucyrus, O.

Plow, Snow
Adams Co., J. D., Indianapolis, Ind.
Austin Western Road Mchy. Co., Chicago, Ill.
Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
E. D. Entyre & Co., Inc., 63 Jefferson St., Oregon, Ill.
Good Roads Mchy. Co., Inc., Kennett Square, Pa.
Klauer Mfg. Co., Dubuque, Ia.
Riddell Co., W. A., Bucyrus, O.
Rightway Corp., Chicago, Ill.
Wehr Company, Milwaukee, Wis.

Plows, Spreader
Bucyrus-Erie Company, Erie, Pa.

Plows, Unloading
Bucyrus-Erie Company, Erie, Pa.

Plumbing Fixtures
Mueller Company, Decatur, Ill.

Plumbing Supplies
Clow & Sons, James B., 201-299 N. Talman Ave., Chicago, Ill.
Mueller Company, Decatur, Ill.

Poles, Steel Structural
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Pools, Swimming
Bacharach & Co., E. W. Kansas City, Mo.
Everson Filter Co., 647 Green St., Chicago, Ill.

Post and Hole Machinery
Buda Company, Harvey, Ill.

Post, Fence
American Steel & Wire Co., Chicago, Ill.
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.

Posts, Indicator Valve
R. D. Wood & Co., Philadelphia, Pa.

Posts and Kettles
H. W. Clark Co., Mattoon, Ill.
The Leadite Company, Philadelphia, Pa.

Posts, Lamp, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.

Poultry Netting
American Steel & Wire Co., Chicago, Ill.

Pouring, Gates
Leadite Company, The, Philadelphia, Pa.

Pouring Pots
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Powder, Blasting
E. I. DuPont de Nemours & Co., Wilmington, Del.

Powder, Railroad
E. I. DuPont de Nemours & Co., Wilmington, Del.

Power Heads
Fairbanks Morse & Co., Chicago, Ill.

Power Units, Gasoline
Buda Company, Harvey, Ill.
Climax Engineering Co., Clinton, Ia.
Continental Motors Corp., Detroit.
Electric Wheel Co., Quincy, Ill.
Hercules Motors Corp., Canton, O.
Leitol Company, Milwaukee, Wis.
Novo Engine Co., 220 Porter St., Lansing, Mich.
Waukesha Motor Co., Waukesha, Wis.
Wisconsin Motor Mfg. Co., Milwaukee.

Power Units Takeoff
Twin Disc Clutch Co., Racine, Wis.

Pressed Steel Products
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Pressure Regulators
H. W. Clark Co., Mattoon, Ill.

Producers, Gas
R. D. Wood & Co., Philadelphia, Pa.

Pulleys, Clutch
Twin Disc Clutch Co., Racine, Wis.

Pumping Plants, Sewage
Economy Pumping Machy. Co., Chicago, Ill.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pump and Engine, Combined
(With Oil Engine.)
Fulton Iron Wks., St. Louis, Mo.

Pump Parts, Rod
Fulton Iron Works Co., St. Louis, Mo.

Pump, Suction and Force
American Well Works, Aurora, Ill.
Coleman, Allan, Chicago, Ill.

Pumps, Air
Chicago Pneumatic Tool Co., 6 East 44th St., New York City.
Ingersoll-Rand Co., New York, N. Y.
Manistee Iron Works, Manistee, Mich.

Pumps, Air Lift
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Artesian Well
American Well Works, Aurora, Ill.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Pumps, Bilge
The Economy Pumping Mchy. Co., Chicago, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Manistee Iron Works, Manistee, Mich.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pumps, Boiler Feed, Steam
Allis-Chalmers Mfg. Co., Milwaukee.
Cameron Steam Pump Wks., A. S. (Ingersoll-Rand Co.), New York City.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works), New York City.
Manistee Iron Works, Manistee, Mich.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Byron Jackson Pump Co., Berkeley, Calif.
The Barnes Mfg. Co., 931 Main St., Mansfield, O.
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Dayton-Dowd Co., Quincy, Ill.
DeLaval Steam Turbine Co., Trenton, N. J.
Domestic Engine & Pump Co., Shippensburg, Pa.
The Economy Pumping Mchy. Co., Chicago, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Layne & Bowler Co., Memphis, Tenn.
Manistee Iron Works, Manistee, Mich.
Peerless Pump Co., Los Angeles, Calif.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pumps, Centrifugal and Multi-Stage High Lift
American Well Works, Aurora, Ill.
Cameron Steam Pump Wks., A. S. (Ingersoll-Rand Co.), New York City.
DeLaval Steam Turbine Co., Trenton, N. J.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works), New York City.
Keystone Driller Co., Beaver Falls, Pa.
Manistee Iron Works, Manistee, Mich.
Novo Engine Co., 220 Porter St., Lansing, Mich.

Pumps, Contractors'
American Well Works, Aurora, Ill.
The Barnes Co., 931 Main St., Mansfield, O.
Blackmer Pump Co., Grand Rapids, Mich.
Cameron Steam Pump Works, A. S. Ingersoll-Rand Co., New York.
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Domestic Engine & Pump Co., Shippensburg, Pa.
Fairbanks, Morse & Co., Chicago, Ill.
Ingersoll-Rand Co. A. S. Cameron Steam Pump Works), New York.
Novo Engine Co., 220 Porter St., Lansing, Mich.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Deepwell
Allis-Chalmers Mfg. Co., Milwaukee.
Amr. Well Works, Aurora, Ill.
Byron Jackson Pump Co., Berkeley, Calif.
DeLaval Steam Turbine Co., Trenton, N. J.
Domestic Engine & Pump Co., Shippensburg, Pa.
The Economy Pumping Mchy. Co., Chicago, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Keystone Driller Co., Beaver Falls, Pa.
Layne & Bowler Co., Memphis, Tenn.
Novo Engine Co., 220 Porter St., Lansing, Mich.
Peerless Pump Co., Los Angeles, Calif.
United Iron Works, Kansas City, Mo.

Pumps, Diaphragm
The Barnes Mfg. Co., 931 Main St., Mansfield, O.
Domestic Engine & Pump Co., Shippensburg, Pa.
Novo Engine Co., 220 Porter St., Lansing, Mich.

Pumps, Drainage
The Barnes Mfg. Co., 931 Main St., Mansfield, O.
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Ingersoll-Rand Co., New York, N. Y.
Economy Pump Machy. Co., Chicago, Ill.
Manistee Iron Wks., Manistee, Mich.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Dredging and Sand
Marion Steam Shovel Co., Marion, O.
Norborn Engineering Co., Darby, Pa.

Pumps, Electric
Allis-Chalmers Mfg. Co., Milwaukee.
Manistee Iron Wks., Manistee, Mich.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Fire Service
Allis-Chalmers Mfg. Co., Milwaukee.
American Well Works, Aurora, Ill.
Manistee Iron Works Co., Manistee, Mich.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pumps, Force
Aeroil Burner Co., Allentown, Pa.
The Barnes Mfg. Co., 931 Main St., Mansfield, O.
Domestic Engine & Pump Co., Shippensburg, Pa.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.

Pumps, Gasoline and Oil
Manistee Iron Wks., Manistee, Mich.

Pumps, Hand
Domestic Engine & Pump Co., Shippensburg, Pa.

Pumps, Multistage High Lift
Allis-Chalmers Mfg. Co., Milwaukee.
Manistee Iron Wks., Manistee, Mich.

Pumps, Piston
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York City.

Pumps, Plunger
The Barnes Mfg. Co., 931 Main St., Mansfield, O.

Pumps, Power
American Well Works, Aurora, Ill.
United Iron Works, Kansas City, Mo.

Pumps, Pumping, Centrifugal and Multi-Stage High Lift
Economy Pumping Machy. Co., Chicago, Ill.

Pumps, Quarry
American Well Works, Aurora, Ill.

Pumps, Reclamation
American Well Works, Aurora, Ill.

Pumps, Road Builders
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Domestic Engine & Pump Co., Shippensburg, Pa.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Novo Engine Co., 220 Porter St., Lansing, Mich.

Pumps, Rotary
Blackmer Pump Co., Grand Rapids, Mich.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Sewage
Allis-Chalmers Mfg. Co., Milwaukee.
American Well Works, Aurora, Ill.
Economy Pump Machy. Co., Chicago, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill. Also 9 Park Place, New York, N. Y.
Yeomans Bros. Co., 1423 Dayton St., Chicago, Ill.

Pumps, Sinking
American Well Works, Aurora, Ill.
Manistee Iron Wks., Manistee, Mich.

Pumps, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.

Pumps, Sump
American Well Works, Aurora, Ill.
Economy Pump Machy. Co., Chicago, Ill.
Fairbanks Morse & Co., Chicago, Ill.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pumps, Trench Portable
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Domestic Engine & Pump Co., Shippensburg, Pa.

Pumps, Triplex
The Economy Pumping Mchy. Co., Chicago, Ill.
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Domestic Engine & Pump Co., Shippensburg, Pa.
Fairbanks Morse & Co., Chicago, Ill.

Pumps, Turbine
Allis-Chalmers Mfg. Co., Milwaukee.
American Well Works, Aurora, Ill.
Manistee Iron Wks., Manistee, Mich.
Peerless Pump Co., Los Angeles, Calif.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Pumps, Underwriters' Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee.
American Well Works, Aurora, Ill.

Pumps, Vacuum
Manistee Iron Works Co., Manistee, Mich.
Chicago Pneumatic Tool Co., New York.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Pumps, Water Works
Allis-Chalmers Mfg. Co., Milwaukee.
American Well Works, Aurora, Ill.
Chicago Pneumatic Tool Co., New York.
DeLaval Steam Turbine Co., Trenton, N. J.
Domestic Engine & Pump Co., Shippensburg, Pa.
Economy Pump Machy. Co., Chicago, Illinois.
Manistee Iron Wks., Manistee, Mich.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Punches, Shank and Bit
Ingersoll-Rand Co., New York, N. Y.

Radiators
Modine Mfg. Co., Racine, Wis.
Young Radiator Co., Racine, Wis.

Railroad Ditchers
Bucyrus-Erie Co., Erie, Pa.
Harnischfeger Corporation, Milwaukee.
Marion Steam Shovel Co., Marion, O.

Rail and Rail Joints
Sweet's Steel Co., Williamsport, Pa.

Railings, Ornamental
The Hughes-Keenan Co., Mansfield, O.

Rails, Relaying
(See Clearing House.)

Rails, Road
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Heltzel Steel Form & Iron Co., Warren, O.
Metal Forms Corp., Milwaukee, Wis.

Rails, Steel
Inland Steel Co., 38 South Dearborn St., Chicago, Ill.

Railway Supplies
Chicago Pneumatic Tool Co., New York, N. Y.
Sweet's Steel Co., Williamsport, Pa.

Railways, Industrial and Portable
Sweet's Steel Co., Williamsport, Pa.

Rakes, Asphalt
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Rammers, Pneumatic
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Ready-Built Buildings
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Receivers, Air
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Mchy. Co., Chicago, Ill.

Recorders, Portable Pitot
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Reheaters, Air
Ingersoll-Rand Co., New York, N. Y.

Reinforcing Concrete
(See Concrete Reinforcement.)

Reinforcing Metal for Concrete Work
American Steel & Wire Co., Chicago.
Concrete Steel Co., New York City.
Ryerson & Son, Jos. T., Chicago, Ill.

Rings, Lamphole
Klauer Mfg. Co., Dubuque, Ia.

Rivet Busters and Sets
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York, N. Y.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Riveting Machines
Chicago Pneumatic Tool Co., New York.

Rivet Heaters, Electric
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.

Rivet Heaters, Oil
Hauck Mfg. Co., Brooklyn, N. Y.

Rivets
Ryerson & Son, Inc., Jos. T., Chicago, Ill.

Road Finisher
A. W. French & Co., Chicago.

Road Finishing Machines
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

CLASSIFIED INDEX OF PRODUCTS

Road Machinery Parts
J. D. Adams Co., Indianapolis, Ind.
French & Hecht Company, Davenport, Ia.
Gallon Iron Works & Mfg. Co., Galion, O.

Road Oils and Preservatives
Solvay Process Company, New York.
Standard Oil Co. of Indiana, Chicago.
Standard Oil Co. of N. Y., New York.

Road Oilers, Pressure
Austin Western Road Machinery Co., Chicago, Ill.
Good Roads Machinery Co., Kennett Square, Pa.

Road Rollers, Gas and Steam
Austin Western Road Machinery Co., Chicago, Ill.
Buffalo-Springfield Roller Co., Springfield, O.

Road Rooter
Ted Carr & Co., Chicago, Ill.
Erie Machine Shops, Erie, Pa.
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.
Gallon Iron Works, Galion, O.
Huber Mfg. Co., Marion, O.

Road Sprinkler
Galion Iron Works & Mfg. Co., Galion, O.

Rock Drill, Accessories
Chicago Pneumatic Tool Co., New York, N. Y.
Sullivan Mchy. Co., Chicago, Ill.

Rods, Sewer & Conduit
Coleman, Allan, Chicago, Ill.

Rods, Wire
American Steel & Wire Co., Chicago.

Rollers, Road
Austin Western Road Machinery Co., Chicago, Ill.
Buffalo-Springfield Roller Co., Springfield, O.
Erie Machine Shops, Erie, Pa.
Galion Iron Works & Mfg. Co., Galion, O.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Huber Mfg. Co., Marion, O.
W. A. Riddell Co., Bucyrus, Ohio.
Universal Road Machinery Co., Kingston, N. Y.
Wehr Company, Milwaukee, Wis.

Rollers, Road, Gasoline
(See Road Rollers.)

Rollers, Road, Horse Drawn
Huber Mfg. Co., Marion, O.

Rollers, Road, Steam
Austin Western Road Machinery Co., Chicago, Ill.
Buffalo-Springfield Roller Co., Springfield, O.
Erie Machine Shops, Erie, Pa.
Huber Mfg. Co., Marion, Ohio.

Rollers, Road, Tandem
Austin Western Road Machinery Co., Chicago, Ill.
Buffalo-Springfield Roller Co., Springfield, O.
Erie Machine Shops, Erie, Pa.
Huber Mfg. Co., Marion, Ohio.

Rollers, Road, Tandem, Steam
(See Rollers, Road Horse Drawn.)

Rolls, Crushing
Allis-Chalmers Mfg. Co., Milwaukee.

Rolls, Grinding, for Various Purposes
Fulton Iron Works Co., St. Louis, Mo.

Roofing (All Kinds)
Carey Company, Philip, Cincinnati, O.
Klauer Mfg. Co., Dubuque, Ia.

Roofing Metal
Ryerson & Son, Inc., Joseph T., Chicago, Ill.

Roofing, Pitch
American Tar Products Co., Pittsburgh.

Roofers
Adams Co., J. D., Indianapolis, Ind.
Ted Carr & Co., Chicago, Ill.

Rope, Wire, Fittings
Maggart Corporation, Chicago, Ill.
Roebling, John A., & Sons Co., Trenton, N. J.

Rope, Wire, Transmission Hoisting or Haulage
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
American Steel & Wire Co., Chicago.
Hazard Wire Rope Co., Wilkes-Barre, Pa.
Page Steel & Wire Co., Bridgeport, Conn.
Roeblings Sons Co., J. A., Trenton, N. J.
Wickwire Spencer Steel Co., New York.
Williamsport Wire Rope, Williamsport, Pa.

Runners, Lock Joint
Coleman, Allan, Chicago, Ill.

Runners, Turbine
American Manganese Bronze Co., Philadelphia, Pa.

Salamanders
Aeroil Burner Co., Inc., Union Hill, N. J.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Sand and Gravel Handling Machines
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Sand and Graveling Plant
Columbia Silica Co., Akron, Ohio.
Northern Gravel Co., Muscatine, Ia.

Sand Blast Sand
The Columbia Silica Co., 38 So. Dearborn St., Chicago, Ill.

Sand Filtration
The Columbia Silica Co., 38 So. Dearborn St., Chicago, Ill.
Northern Gravel Co., Muscatine, Ia.
Tamms Silica Co., Chicago, Ill.

"Sand Spun" Pipe
R. D. Wood & Co., Philadelphia, Pa.

Sash, Steel
Ryerson Steel Co., Chicago.

Saws, Rigs, Portable
C. H. & E. Manufacturing Co., Milwaukee, Wis.
Knickerbocker Co., Jackson, Mich.

Saws, Rail
Industrial Brownhoist Corp., Cleveland.

Scaffolding, Steel Tubular
Patent Scaffolding Co., New York City.

Scaffolds—Swinging, All Types
Patent Scaffolding Co., New York City.

Scales, All Kinds
Fairbanks, Morse & Co., Chicago, Ill.

Scales for Meter Testers
Clark Co., H. W., Mattoon, Ill.

Scarifiers
Ted Carr Co., Chicago, Ill.
Killefer Mfg. Co., Los Angeles, Calif.
Western Wheeled Scraper Co., Aurora, Ill.

Scarifiers and Road Graders
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Mchy. Co., Chicago, Ill.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
W. A. Riddell Co., Bucyrus, O.
Wehr Co., Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.

Schools & Colleges
(See Directory of Engineers.)

Scrapers, Drag
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Machinery Co., Chicago, Ill.
L. P. Green, Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Scrapers, Drag, Power
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Scrapers, Dragline
Garst Mfg. Company, Chicago, Ill.
Sauerman Brothers, Inc., 438 S. Clinton St., Chicago, Ill.

Scrapers, Fresno
J. D. Adams Co., Indianapolis, Ind.
Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Klauer Mfg. Co., Dubuque, Ia.
Western Wheeled Scraper Co., Aurora, Ill.

Scrapers, Four-Wheel, Self-Loading
J. D. Adams Co., Indianapolis, Ind.
Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.

Scrapers, Mormon
J. D. Adams Co., Indianapolis, Ind.

Scrapers, Power Plow
Garst Mfg. Co., Chicago, Ill.

Scrapers, Scarifiers, Plows, Etc.
J. D. Adams Co., Indianapolis, Ind.
Anthony Co., Streator, Ill.
Austin Western Road Machinery Co., Chicago, Ill.
Ted Carr Co., Chicago, Ill.
Killifer Mfg. Co., Los Angeles, Calif.
Multifoote Co., Nunda, N. Y.
Roderick Lean Co., Mansfield, O.
Speeder Mchy. Corp., Cedar Rapids, Ia.
Western Wheel Scraper Co., Aurora, Ill.

Scrapers, Slip
J. D. Adams Co., Indianapolis, Ind.
Burch Corporation, Crestline, O.

Scrapers, Wheel
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Machinery Co., Chicago, Ill.
Galion Iron Works, Galion, O.
Western Wheeled Scraper Co., Aurora, Ill.

Screening Plants, Sand and Gravel
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.

Screens, Conical Revolving
Allis-Chalmers Mfg. Co., Milwaukee.

Screens, Gravel Washing
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Screens, Intake
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Screens, Revolving
Austin Western Road Machinery Co., Chicago, Ill.
Converse Co., Inc., Johnson City, N. Y.
Haiss Mfg. Co., Geo., New York City.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Pioneer Gravel Equipment-Mfg. Co., Minneapolis, Minn.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Universal Road Machinery Co., Kingston, N. Y.

Screens, Sand, Gravel and Coal
Austin Western Road Machinery Co., Chicago, Ill.

Screens, Shaker
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Haiss Mfg. Co. Inc., Geo., New York.
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Pioneer Gravel Equipment-Mfg. Co., Minneapolis, Minn.
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Western Wheeled Scraper Co., Aurora, Ill.
Wickwire Spencer Steel Co., New York.

Screens, Stone
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.
Universal Crusher Co., Cedar Rapids, Ia.

Screens, Water Intake
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Screens, Well
Layne & Bowler Co., Memphis, Tenn.

Segment Blocks
Clay Products Assn., Chicago, Ill.

Service Boxes
Clark Co., H. W., Mattoon, Ill.
Mueller Company, Decatur, Ill.

Second-Hand Equipment
(See Clearing Section.)

Sewage Disposal Apparatus
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill. Also 9 Park Place, New York, N. Y.

Sewage Ejectors
The Economy Pumping Machy. Co., Chicago, Ill.
Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill.

Sewer and Basin Dips
Coleman, Allan J., Chicago, Ill.

Sewer Flushers or Plugs
Petersens Hydraulic Sewer Flusher Co., Milwaukee, Wis.

Sewer, Joint Compounds
Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill. Also 9 Park Place, New York N. Y.
Reading Meter Repair Co., Reading, Pa.

Sewer Rods Flat Wire
Coleman, Allan, Chicago, Ill.

Sewers Storm
Armco Culvert Mfrs. Assn., Middletown, O.

Shaft Caps
American Manganese Bronze Co., Philadelphia, Pa.

Shanking Machines, Drill Steel
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machy. Co., Chicago, Ill.

Sharpeners, Rock, Drill, Steel
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Sharpening Machines Drill Bit
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Sheathing Paper
Philip Carey Co., Cincinnati, O.

Sheaves
Haiss Mfg. Co., Inc., Geo., New York.
Western Block Co., Lockport, N. Y.
Williamsport Wire Rope Co., Williamsport, Pa.

Sheet Metal Products
Klauer Mfg. Co., Dubuque, Ia.

Sheets, Iron and Steel
Ryerson & Son, Joseph T., Chicago.

Sheets, Roofing and Siding
Armco Culvert Mfrs. Assn., Middletown, O.
Ryerson & Son, Joseph T., Chicago, Ill.

Shingles, Asphalt
Carey Co., Philip, The, Cincinnati, O.

Shouder Machines
Highway Shoulder Co., Effingham, Ill.

Shovel (Power) Parts
General Excavators Co., Marion, O.
Ohio Power Shovel Co., Lima, O.

Shovels, Asphalt
General Excavators Co., Marion, O.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Shovels, Crawling Tractors
Thew Shovel Co., Lorain, O.

Shovels, Creeper
Harnischfeger Corporation, Milwaukee, Wis.
Industrial Brownhoist Corp., Cleveland, O.

Shovels, Diesel
Bucyrus-Erie Company, Erie, Pa.
Harnischfeger Corporation, Milwaukee, Wis.
Industrial Brownhoist Corp., Cleveland, O.

Shovels, Electric
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
Harnischfeger Corporation, Milwaukee.
Industrial Brownhoist Corp., Cleveland.
Keystone Driller Co., Beaver Falls, Pa.
Link Belt Co., 2045 W. Hunting Park Ave. Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co. Marion, O.
The Osgood Co., Marion, O.
Thew Shovel Co., Lorain O.

Shovels Electric Crawler
Harnischfeger Corp., Milwaukee, Wis.

Shovels, Fordson
Insley Mfg. Co., Indianapolis Ind.
Universal Power Shovel Co., Detroit.

Shovels, Gasoline
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bay City Dredge Wks., Bay City, Mich.
Bucyrus-Erie Company, Erie, Pa.
General Excavators Co., Marion, O.
Harnischfeger Corporation, Milwaukee.
Industrial Brownhoist Corp., Cleveland.
Insley Mfg. Co., Indianapolis, Ind.
Koehring Company, Milwaukee, Wis.
Link Belt Co. 2045 W. Hunting Park Ave. Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion O.
Ohio Power Shovel Co., Lima, O.
Orton Crane & Shovel Co., Chicago, Ill.
Osgood Co., Marion, O.
Speeder Mchy. Corp. Cedar Rapids Ia.
Thew Shovel Co., Lorain, O.
Trackson Co., 433 Clinton St., Milwaukee Wis.
Universal Crane Co. Lorain, O.
Universal Power Shovel Co., Detroit.

Shovels, Gasoline Crawler
General Excavators Co., Marion, O.
Harnischfeger Corp., Milwaukee, Wis.
Industrial Brownhoist Co., Cleveland.
Speeded Machinery Co., Cedar Rapids, Ia.

Shovels, Hand
Wood Shovel & Tool Co., Piqua, O.

Shovels, Revolving
(See Gasoline Shovels.)

Shovels, Snow
Rightway Corporation, Chicago, Ill.

Shovels, Steam
American Hoist & Derrick Co., 93 South Robert St., St. Paul, Minn.
Bucyrus-Erie Company, Erie, Pa.
Harnischfeger Corporation, Milwaukee.
Industrial Brownhoist Corp., Cleveland.
Keystone Driller Co., Beaver Falls, Pa.
Marion Steam Shovel Co., Marion, O.
Orton Crane & Shovel Co., Chicago.
Osgood Company, Marion, O.
Thew Shovel Co., Lorain, O.

Shovels, Steam Crawler
Industrial Brownhoist Corp., Cleveland.

Signs, Highway
Armco Culvert & Flume Mfrs., Assn., Middletown, O.
Foote Bros. Gear & Mach. Co., Chicago, Ill.

Silicate, Soda
Philadelphia Quartz Co., Philadelphia, Pa.

Siphons
Armco Culvert Mfrs. Assn., Middletown, O.
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.

CLASSIFIED INDEX OF PRODUCTS

Skimmer
Bay City Dredge Wks., Bay City, Mich.
Byers Machine Co., Ravenna, O.
Insley Mfg. Co., Indianapolis, Ind.
Keystone Driller Co., Beaver Falls, Pa.

Skips, Stone
Insley Mfg. Co., Indianapolis, Ind.

Skylights
Klauer Mfg. Co., Dubuque, Ia.

Sleeves, Tapping (Valve)
Darling Valve & Mfg. Co., Williamsport, Pa.

Sludge Collector
Link Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Sluice Gates
American Manganese Bronze Co., Philadelphia, Pa.
Clark Company, H. W., Mattoon, Ill.
U. S. Cast Iron Pipe & F'dry. Co., Burlington, N. J.

Smoke Stacks
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.

Smoothers, Asphalt
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Snow Loaders
Barber-Greene Co., Aurora, Ill.
Haiss Mfg. Co., Geo., New York City.

Snow Plows
J. D. Adams Co., Indianapolis, Ind.
Austin Western Road Machy. Co., Chicago, Ill.
Good Roads Machy. Co., Inc., Kennett Square, Pa.
Klauer Mfg. Co., Dubuque, Ia.

Snow Removal Machinery
Barber-Greene Co., Aurora, Ill.

Spaders
Concrete Steel Co., New York, N. Y.
Sullivan Machinery Co., 819 Wrigley Bldg., Chicago, Ill.

Spark Plugs
Robert Bosch Mfg. Co., Long Island City, N. Y.

Spikes, Spirits and Splice Bars
Sweet's Steel Co., Williamsport, Pa.

Spirals
Ryerson & Son,, Inc., Jos. T., Chicago.

Spoon, Sewers and Basin
Coleman, Allan, Chicago, Ill.

Spreaders
Burch Corp., Crestline, O.
Goroco Mechanical Spreader Co., Philadelphia, Pa.
Universal Road Machy. Co., Kingston, N. Y.

Spreaders, Ballast
Bucyrus-Erie Company, Erie, Pa.

Sprinklers and Sweepers, Street
Austin Western Rd. Machy. Co., Chicago.
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Geo. W. Haiss Mfg. Co., Inc., New York, N. Y.
Universal Road Machy. Co., Kingston, N. Y.

Squibs, Electric
E. I. DuPont de Nemours & Co., Wilmington, Del.

Stairs, Steel
Hughes-Keenan Co., Mansfield, O.

Standards, Lamp, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.

Standpipes
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Connery & Company, Philadelphia.
R. D. Cole Mfg. Co., Newman, Ga.
Fairbanks, Morse & Co., Chicago, Ill.
Pittsburgh-Des Moines Steel, Pittsburgh, Pa.

Steam Purifiers
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Steel
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Ryerson & Son, Joseph T., Chicago.

Steel Plate Construction
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
R. D. Cole Mfg. Co., Newnan, Ga.
Connery & Co., Inc., 3996 N. Second St., Philadelphia, Pa.
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.
Pittsburgh-Des Moines Steel, Pittsburgh, Pa.
Williams Co., G. H., Erie, Pa.

Steel Rock Drill
Chicago Pneumatic Tool Co., New York City.
Ingersoll-Rand Co., New York City.
Schramm, Inc., West Chester, Pa.
Sullivan Machy. Co., Chicago.

Steel, Structural
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Hughes-Keenan Co., Mansfield, O.
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Steel Traffic Treads
Wood Steel Co., Alan, Conshohocken Pa.

Sterilizing Systems
Everson Filter Co., 647 N. Green St., Chicago, Ill.

Sterilizer, Water
Wallace & Tiernan, Newark, N. J.

Stirrups, Continuous Reinforcing Units
Ryerson & Son, Jos. T., Chicago.

Stoneboats
Lee Trailer & Body Co., Plymouth, Ind.

Stoppers, Pipe
Safety Gas Main Stopper Co., 523 Atlantic Ave., Brooklyn, N. Y.

Stoppers, Water Mains, Etc.
Safety Gas Main Stopper Co., New York City.

Stops, Curb, Gooseneck
Mueller Co., Decatur, Ill.

Strand (Guy, Special and Transmission)
John A. Roebling's Sons Co., Trenton, N. J.

Strainers
Fulton Iron Works Co., St. Louis, Mo.

Strainers, Well
Layne & Bowler Co., Memphis, Tenn.
F. Thorpe. 1932 Illinois Ave., East St. Louis, Ill.

Street Flushers
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.

Street Light Standards
Novo Engine Co., 220 Porter St., Lansing, Mich.

Street Sprinklers
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.

Street Sweeping Material
Huntsville Fiber & Veneer Wks., Huntsville, Ala.

Strip, Road
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Jos. T. Ryerson & Son, Inc., Chicago, Ill.

Subgrade Finishing Machines
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Subgrade Markers, Highway
Roughan Paving Gauge Co., Fond du Lac, Wis.

Subgrading Machines
The Hug Co., Highland, Ill.

Supplies, Heating, Steam and Gas.
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.

Supplies, Hydraulic
Clark Co., H. W., Mattoon, Ill.

Surfacer, Highway
Concrete Surfacing Machy. Co., Cincinnati, O.
Ingersoll-Rand Co., New York, N. Y.

Surveying Instruments
Buff & Buff Mfg. Co., Boston, Mass.
Warren-Knight Co., Philadelphia, Pa.

Sweepers, Street
Austin Western Rd. Machy. Co., Chicago, Ill.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Universal Road Machinery Co., Kingston, N. Y.

Swimming Pool Filter Systems
Bacharach & Co., E. W., Kansas City, Mo.

Swimming Pools & Equipment
Everson Filter Co., 647 No. Green St., Chicago, Ill.

Switches, Portable
Sweet's Steel Co., Williamsport, Pa.

Tables, Transfer
Industrial Brownhoist Corp., Cleveland.

Tampers, Trench
Chicago Pneumatic Tool Co., New York, N. Y.
Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.
Schramm, Inc., West Chester, Pa.

Tank Car Heaters
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.

Tanks
R. D. Cole Mfg. Co., Newnan, Ga.
Jos. Honhorst Co., Cincinnati, O.
Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill. Also 9 Park Place, New York, N. Y.

Tanks, Air Compressor
Chicago Pneumatic Tool Co., New York.
R. D. Cole Mfg. Co., Newman, Ga.

Tanks, Elevated Steel, Water
R. D. Cole Mfg. Co., Newnan, Ga.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Tanks, Oil Storage
Mohawk Asphalt Heater Co., Schenectady, N. Y.

Tanks, Sand Settling
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Tanks, Septic
Mohawk Asphalt Heater Co., Schenectady, N. Y.

Tanks, Sprinkling
Entyre & Co., Inc., E. D., 63 Jefferson St., Oregon, Ill.

Tanks, Steel
Clark Co., H. W., Mattoon, Ill.
R. D. Cole Mfg. Co., Newnan, Ga.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Tapping Machines
Mueller Co., Decatur, Ill

Tar Heaters, Kettles
Hauck Mfg. Co., Brooklyn, N. Y.
Honhorst Co., Jos., Cincinnati.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Tar, Road
American Tar Products Corp., Pittsburgh, Pa.
Barrett Co., New York, N. Y.

Tarvia
Barrett Co., New York, N. Y.

Tar and Pitch, Paving
(See Road Tar.)

Tees, Threadless
Geo. H. Snell, Attleboro, Mass.

Teeth, Dipper and Bucket
Western Crucible Steel Casting Co., Minneapolis, Minn.

Teeth, Scarifier
Western Crucible Steel Casting Co., Minneapolis, Minn.

Telephones (Bell System)
Amer. Tel. & Teleg. Co., New York.

Templates, Subgrade
Hug Co., Highland, Ill.

Templets, Highway Strike Off
Roughan Paving Gauge Co., Fond du Lac, Wis.

Testers, Water Meter
Clark Co., H. W., Mattoon, Ill.

Tests, Road Material
Hug Co., Highland, Ill.

Testing Laboratories
(See Engineers' Directory.)

Thawing Equipment
Aeroil Burner Co., West New York, N. J.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Ties, Steel
Sweet's Steel Co., Williamsport, Pa.

Tile, Drain
Clay Products Assn., Chicago, Ill.
Wm. Dee Clay Mfg. Co., Chicago, Ill.

Tires, Rubber
Goodrich Rubber Co., B. F., Akron, O.
Hood Rubber Co., Watertown, Mass.

Tools, Asphalt Paving
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Tool Boxes, Portable
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Tools, Caulking
Clark Co., H. W., Mattoon, Ill.
Leadite Co., Philadelphia, Pa.
Mueller Co., Decatur, Ill.
Schramm, Inc., West Chester, Pa.

Tools, Electric
Chicago Pneumatic Tool Co., New York.

Tools, Hand, Blacksmith
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Tools, Hydraulic
Clark Co., H. W., Mattoon, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Tools, Mechanic
Ryerson & Son, Inc., Jos. T., Chicago.

Tools, Pipe Jointing
Leadite Co., Philadelphia, Pa.

Tools, Pneumatic
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Torch, Gasoline Blow
Hauck Mfg. Co., Brooklyn, N. Y.
G. H. Williams Co., Erie, Pa.

Torches, Bomb Shell
McCloskey Torch Co., Toledo, O.

Torches, Road
McCloskey Torch Co., Toledo, O.
National Carbon Co., New York, N. Y.
Toledo Pressed Steel Co., Toledo, O.

Torches, Thawing, Oil and Kerosene
Aeron Burner Co., Inc., Union Hill, N. J.
Hauck Mfg. Co., Brooklyn, N. Y.
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Towers, Concrete
(See Hoists, Conc. Tower.)

Towers, Radio
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Towers, Transmission
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Track, Industrial and Portable
Ryerson & Son, Inc., Jos. T., Chicago.
Sweet's Steel Co., Williamsport, Pa.

Traction, Crawling Type
Trackson Co., Milwaukee.

Tractors
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Atlas Engr. Co., Clintonville, Wis.
Caterpilar Tractor Co., San Leandro, Cal.
Cleveland Tractor Co., 10320 Euclid Ave., Cleveland, O.
Electric Wheel Co., Quincy, Ill.
Foote Bros. Gear & Mach. Co., Chicago, Ill.
French & Hecht Co., Davenport, Ia.
Haiss Mfg. Co., Inc., Geo., New York.
International Harvester Co., Chicago.
Monarch Tractor Corp., Springfield, Ill.

Tractors, Crawler, Traction and Caterpillar
(See Tractors.)

Tractors, Industrial
International Harvester Co. of America, Chicago, Ill.

Tractors, Road
Trackson Co., 533 Clinton St., Milwaukee, Wis.

Tractors, Road Gasoline
(See Tractors.)

Tractors, Truck
International Harvester Co. of America, Chicago, Ill.

Tractors, Wheel
International Harvester Co. of America, Chicago, Ill.

Tractor Scraper
Roderick Lean Co., Mansfield, O.

Trailers, All Kinds
Electric Wheel Co., Quincy, Ill.
French & Hecht, Davenport, Ia.
Freuhauf Trailer Company, 10937 Harper Ave., Detroit, Mich.
Highway Trailer Co., Edgerton, Wis.
Lee Trailer & Body Co., Plymouth, Ind.
Martin Trailer Co., Westfield, Mass.
Rogers Bros. Corp., Albion, Pa.

Traffic Marker
Littleford Bros., 454 E. Pearl St., Cincinnati, O.

Traffic Signals
Wallace & Tiernan, Inc., Newark, N. J.

Traffic Treads, Steel
Wood Steel Co., Alan, Conshohocken, Pa.

Tramways, Overhead
Harnischfeger Corp., Milwaukee, Wis.

Transits and Levels
Buff & Buff Mfg. Co., Boston, Mass.
Kern & Co., New York, N. Y.
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.

Transmission and Machinery Power
Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.

Treads, Safety
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Concrete Steel Co., New York, N. Y.
Ryerson & Son., Inc., Jos. T., Chicago.

Treads, Traffic Steel (Bridges)
American Pressed Steel Co., Philadelphia, Pa.
Central Iron & Steel Co., Harrisburg, Pa.
Wood Steel Co., Alan, Conshohocken, Pa.

Trenchers
Bay City Dredge Wks., Bay City, Mich.
Buckeye Traction Ditcher Co., Findlay, Ohio.
Harnischfeger Corp., Milwaukee, Wis.

Trench Braces
(See Braces, Trench.)

Trench Machines
Buckeye Traction Ditcher Co., Findlay, Ohio.

CLASSIFIED INDEX OF PRODUCTS

Trolleys, I-Beams
Harnischfeger Corp., Milwaukee, Wis.

Trucks, Dump
Graham Brothers, Detroit, Mich.
Hug Co., Highland, Ill.
International Harvester Co. of America, Chicago, Ill.

Trucks
Chevrolet Motor Company, Detroit, Mich.
General Motors (Chevrolet), Detroit.
Graham Bros., Detroit, Mich.
Hug Co., Highland, Ill.
International Harvester Co. of America, Chicago, Ill.

Trucks, Machinery
Electric Wheel Co., Quincy, Ill.
Lee Trailer & Body Co., Plymouth, Ill.

Trucks, Portable Machinery
(See Trucks, Machinery.)

Trusses, Steel, Roof
Concrete Steel Co., New York, N. Y.

Tubular Steel Scaffolding
Patent Scaffolding Co., New York, N. Y.

Tunnel Liner Plates
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Turbine Gears
DeLaval Steam Turbine Co., Trenton, N. J.

Turbines, Hydraulic Impulse and Reaction
Allis-Chalmers Mfg. Co., Milwaukee.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee.
DeLaval Steam Turbine Co., Trenton, N. J.

Turnbuckles
Coleman, Allan, Chicago, Ill.
Maggart Corp., Chicago, Ill.
Williamsport Wire Rope Co., Williamsport, Pa.

Turnouts
Sweet's Steel Co., Williamsport, Pa.

Turntables
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.
Hug Co., Highland, Ill.
Western Structural Co., Moline, Ill.

Unloaders, Ballast
Lidgerwood Mfg. Co., Elizabeth, N. J.
Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.

Unloaders, Car and Wagon
Atlas Engineering Co., Clintonville, Wis.
Galion Iron Works Mfg. Co., Galion, O.
Good Roads Machinery Co., Inc., Kennett Square, Pa.
Haiss Mfg. Co., Geo., New York, N. Y.
Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Industrial Brownhoist Co., Cleveland, Ohio.
Universal Road Machinery Co., Kingston, N. Y.

Unloaders, Coal and Stone
(See Unloaders, Car and Wagon.)

Unloading Plants
Atlas Engineering Co., Clintonville, Wis.
Bucyrus-Erie Co., Erie, Pa.

Valve Boxes
Bourbon Copper & Brass Works Co., 618-620 E. Front St., Cincinnati, O.
Reading Meter Repair Co., Reading, Pa.
Central Foundry Co., New York, N. Y.
Clark Co., H. W., Mattoon, Ill.
Columbia Iron Works, Chattanooga, Tenn.
Klauer Mfg. Co., Dubuque, Ia.
Mueller Co., Decatur, Ill.
S. E. T. Valve & Hydrant Co., New York, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Valve Check
Columbia Iron Works, Chattanooga, Tenn.

Valve Operating Parts
American Manganese Bronze Co., Philadelphia, Pa.

Valves
American Manganese Bronze Co., Philadelphia, Pa.
James B. Clow & Sons, 201-299 N. Talman Ave., Chicago, Ill.
Crane Co., Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
S. E. T. Valve & Hydrant Co., New York, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Valves, Air, Water, Steam and Gas
Automatic Cone Valve Co., Chicago, Ill.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Valves, Altitude
Automatic Cone Valve Co., Chicago, Ill.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.

Valves, Air-Vacuum
Automatic Cone Valve Co., Chicago, Ill.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Valves, Angle, Check, Gate and Globe
Automatic Cone Valve Co., Chicago, Ill.
Bourbon Copper & Brass Works Co., 618-620 E. Front St., Cincinnati, O.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Mueller Co., Decatur, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Valves, Automatic
Automatic Cone Valve Co., Chicago, Ill.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Valves, Chlorine Cylinder
Wallace & Tiernan, Newark, N. J.

Valves, Fire Service
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Mueller Co., Decatur, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Valves, Float
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Mueller Co., Decatur, Ill.

Valves, Foot
Mueller Co., Decatur, Ill.

Valves, Gate
Columbian Iron Works, Chattanooga, Tenn.
Darling Valve & Mfg. Co., Williamsport, Pa.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Valves, Flush
Mueller Co., Decatur, Ill.

Valves, Hydraulic
R. D. Wood & Co., Philadelphia, Pa.

Valves, Pipe
(See Valves, Angle Check Gate and Globe.)

Valves, Regulating
Automatic Cone Valve Co., Chicago, Ill.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
Simplex Valve & Meter Co., 6749 Upland St., Philadelphia, Pa.

Valves, Water Relief
(See Valves, Angle, Check, Gate and Globe.)

Valves, Return
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.

Valves, Safety
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.

Valves, Water Works
Automatic Cone Valve Co., Chicago, Ill.
Columbian Iron Works, Chattanooga, Tenn.
Darling Valve & Mfg. Co., Williamsport, Pa.
Golden-Anderson Valve Specialty Co., 1385 Fulton Bldg., Pittsburgh, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Vats, Cast Iron
Fulton Iron Works Co., St. Louis, Mo.

Ventilator, Shop, Roundhouses
Klauer Mfg. Co., Dubuque, Ia.

Wagons, Asphalt
J. D. Adams Co., Indianapolis, Ind.

Wagons, Dump
J. D. Adams Co., Indianapolis, Ind.
Austin Western Rd. Mchy. Co., Chicago, Ill.
The Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Wagons, Dump, Auto
Austin Western Rd. Mchy. Co., Chicago, Ill.

Wagons, Dump, Horse Drawn
J. D. Adams Co., Indianapolis, Ind.
Western Wheeled Scraper Co., Aurora, Ill.

Wagons, Grader
Blaw-Knox Co., 603 Farmers Bank Bldg., Pittsburgh, Pa.

Wall Coping
Clay Products Assn., Chicago, Ill.

Washers
Smith Engineering Works, 82 Capitol Drive, Milwaukee, Wis.

Washers, Rawhide Meter
Mabba Hydraulic Packing Co., Chicago, Ill.

Washing Plants, Sand and Gravel
Allis-Chalmers Mfg. Co., Milwaukee.
Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.; 300 W. Pershing Rd., Chicago, Ill.
Universal Road Machinery Co., Kingston, N. Y.

Water Coolers
Everson Filter Co., 647 N. Green St., Chicago, Ill.

Water Leak, Locating Instruments
Clark Co., H. W., Mattoon, Ill.
Reading Meter Repair Co., Reading, Pa.

Water, Level Recorders
Clark Co., H. W., Mattoon, Ill.

Water-Main Cleaning
National Water Main Cleaning Co., New York, N. Y.

Water Main Sterilizer
Wallace & Tiernan, Newark, N. J.

Waterproofing Oil, Asphalt
American Asphalt Grouting Co., Chattanooga, Tenn.
Standard Oil Co. of Ind., Chicago, Ill.
Standard Oil Co. of N. Y., New York.
Texas Co., New York, N. Y.

Waterproofing Compounds and Materials
Barrett Co., New York, N. Y.
Philip Carey Co., Cincinnati, O.
Ceresit Waterproofing Corp., Chicago.
Servicised Products Corp., Chicago, Ill.

Water, Purification
Bacharach & Co., E. W., Kansas City, Mo.
Everson Filter Co., 647 No. Green St., Chicago, Ill.
Paradon Engineering Co., Arlington, N. J.
Wallace & Tiernan, Inc., Newark, N. J.

Water Softeners
Crane Co., Chicago, Ill.
Everson Filter Co., 647 N. Green St., Chicago, Ill.
Zeolite Chemical Co., 140 Cedar St., New York, N. Y.

Water Works Supplies
Clark Co., H. W., Mattoon, Ill.
Mueller Co., Decatur, Ill.

Weed Burners
Hauck Mfg. Co., Brooklyn, N. Y.

Welded Fabric
Wickwire Spencer Co., New York, N. Y.

Welders, Electric
American Hoist & Derrick Co., 93 S. Robert St., St. Paul, Minn.
Klauer Mfg. Co., Dubuque, Ia.

Welding, Wire
John A. Roebling's Sons Co., Trenton, N. J.

Well Casings, Concrete
F. Thorpe, 1932 Illinois Ave., East St. Louis, Ill.

Well Drilling Machinery
American Well Works, Aurora, Ill.
Austin Mfg. Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Keystone Driller Co., Beaver Falls, Pa.
Layne & Bowler Co., Memphis, Tenn.
F. Thorpe, 1932 Illinois Ave., East St. Louis, Ill.

Well Equipment
American Well Works, Aurora, Ill.

Wells, "Air Made"
Sullivan Machy. Co., 819 Wrigley Bldg., Chicago, Ill.

Wells
Layne & Bowler Co., Memphis, Tenn.
F. Thorpe, 1932 Illinois Ave., East St. Louis, Ill.

Wells, Concrete
F. Thorpe, 1932 Illinois Ave., East St. Louis, Ill.

Wheels, Metal
Electric Wheel Co., Quincy, Ill.
French & Hecht, Davenport, Ia.

Wheels, Rubber Tired
(See Wheels, Metal.)

Wheels, Steel
French & Hecht, Davenport, Ia.

Winches
American Hoist & Derrick Co., 93 S. Robert St., St. Paul, Minn.
Chicago Pneumatic Tool Co., New York, N. Y.
Haiss Mfg. Co., Inc., Geo., New York.
Lidgerwood Mfg. Co., Elizabeth, N. J.

Winches, Motor Truck
Bay City Foundry & Machine Co., Bay City, Mich.
Chevrolet Motor Company, Detroit, Mich.

Winches, Ship, Hand, Steam and Electric
Lidgerwood Mfg. Co., Elizabeth, N. J.

Windlasses
American Hoist & Derrick Co., 93 S. Robert St., St. Paul, Minn.

Window Sash Steel
Ryerson & Son., Inc., Jos. T., Chicago.

Windows, Steel
Ryerson & Son, Inc., Jos. T., Chicago.

Wires and Cables (All Purposes)
American Steel & Wire Co., Chicago.
John A. Roebling's Sons Co., Trenton, N. J.

Wire Brushes, Pneumatic
Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.

Wire, Electrical and Cable
John A. Roebling's Sons Co., Trenton, N. J.

Wire Fence
American Steel & Wire Co., Chicago.
American Wire Fence Co., Chicago.
Page Steel & Wire Co., Bridgeport, Conn.

Wire, Leading and Connecting
E. I. DuPont de Nemours & Co., Inc., Wilmington, Del.

Wire, Mesh Reinforcing
American Steel & Wire Co., Chicago.
Wickwire Spencer Steel Co., New York, N. Y.

Wire Rope
(See Rope, Wire.)

Wire Rope Fittings
(See Rope, Wire, Fittings.)

Wire Rope Slings
John A. Roebling's Sons Co., Trenton, N. J.

Wire, Steel
American Steel & Wire Co., Chicago, Ill.

Wood Boring Machines, Pneumatic
Chicago Pneumatic Tool Co., New York, N. Y.
Ingersoll-Rand Co., New York, N. Y.
Schramm, Inc., West Chester, Pa.

Wood Preservative
Philip Carey Co., Cincinnati, O.

Wrenches
Trimont Mfg. Co., Boston, Mass.

Wrenches, Strap
Coleman, Allen, Chicago, Ill.

Yokes, Coupling
Clark Co., H. W., Mattoon, Ill.

GEOGRAPHICAL INDEX OF DEALERS AND DISTRIBUTORS

Note: Each equipment distributor's name is followed by the name of the firms whose products he handles.
The alphabetical index of firms will be found on page 5.
See also lists on individual pages.

ALABAMA

Birmingham

Chas. T. Lehman
2300 Avenue A.
Schramm, Inc.
U. S. Cast Iron Pipe & Fdy. Co.
First Ave. and 20th St.
Wimberly & Thomas Hdw.
McCloskey Torch Company

Mobile

Lawrence-Goodling Co., Inc.
161-165 N. Water St.
Schramm, Inc.

ARIZONA

Phoenix

Arizona Road Machinery Company
Schramm, Inc.
James G. Bain
211 Security Bldg.
Economy Pumping Mach. Co.
Vernon L. Clark Bldg. Mat. Co.
341 N. 1st St.
McCloskey Torch Company
Neil B. McGinnis
15 E. Jackson St.
McCloskey Torch Company

Tucson

Machinery Engineering Co.
246 E. Broadway
Schramm, Inc.

Yuma

J. D. Lines
1120 5th Ave.
Peerless Pump Co.

ARKANSAS

Ft. Smith

Speer Hardware Co.
McCloskey Torch Company

Little Rock

Kern-Limerick, Inc.
2800 W. 15th St.
Schramm, Inc.
Joe Lyons Machinery Co.
112 N. Louisiana St.
McCloskey Torch Company
C. O. Miller Co.
Home Insurance Bldg.
Yeomans Bros.

CALIFORNIA

Bakersfield

Peerless Pump Company
1514 20th St.

Fresno

Peerless Pump Company
1225 Broadway St.

Lancaster

Siebenthal Bros.
Peerless Pump Company

Los Angeles

Construction Machinery Co.
455 E. Third St.
Schramm, Inc.
F. C. Millard Enginering Co.
1855 Industrial St.
Yeomans Bros. Co.
Republic Flow Meters Co.
U. S. Cast Iron Pipe & Fdy. Co.
403 S. Hill St.
Wallace & Tiernan Co., Inc.
G. T. Luippold, 3923 W. 6th St.
Water Works Supply Co.
Wright & Callender Bldg.
Automatic Cone Valve Co.
Golden Anderson Valve Spec. Co.
Simplex Valve & Meter Co.
R. D. Wood & Co.
Jones-Lyman & Co., Inc., Bartlett Bldg., 215 W. 7th St.

Oakland

Spears-Wells Machinery Co.
Schramm, Inc.

Sacramento

Peerless Pump Company
1327 O St.

San Francisco

C. H. Cobb
55 New Montgomery St.
Yeomans Bros. Co.
Industrial & Municipal Supply Co., Inc.
Room 314, 7 Front St.
Peerless Pump Company
Jenison Machinery Co.
58 Fremont St.
McCloskey Torch Company
Republic Flow Meters Co.
J. Harry Russell
Monadnock Bldg.
Economy Pumping Machy. Co.
U. S. Cast Iron Pipe & Fdry. Co.
3rd and Market Sts.
Wallace & Tiernan Co., Inc.
Alex. Bell, 7 Front St.
Water Works Supply Co.
Sharon Bldg.
Automatic Cone Valve Co.
Golden Anderson Valve Spec. Co.
Simplex Valve & Meter Co.
R. D. Wood & Co.
Jones-Lyman & Co., Inc., Russ Bldg., 235 Montgomery St.

San Jose

Peerless Pump Company
635 S First St.

Tulare

Figgins & Curtis
South K and Owens Sts.
Peerless Pump Company

COLORADO

Denver

Daly Co.
1635 Blake St.
Yeomans Bros. Co.
Denver Fire Clay Company
Simplex Valve & Meter Co.
H. W. Moore Equipment Co.
Sixth and Acoma Sts.
Schramm, Inc.
Republic Flow Meters Co.
Wallace & Tiernan Co., Inc.
C. R. Cederberg, 5531 E. 14th St.

CONNECTICUT

East Hartford

Holmes Talcott Co.
McCloskey Torch Company

Hartford

K. B. Noble Co.
249-251 Pearl St.
McCloskey Torch Company

New Haven

W. I. Clark Co.
217 Lafayette St.
McCloskey Torch Company
Gesner Contractors Equipment Co.
254 Park St.
Schramm, Inc.

DELAWARE

Wilmington

Delaware Hdw. Co.
McCloskey Torch Company

DISTRICT OF COLUMBIA

Washington

Hudson Supply & Equipment Co.
7th and T Sts.
McCloskey Torch Company
Stewart Motor Co.
346 W. Penn. Ave., N. W.
Schramm, Inc.

FLORIDA

Ft. Lauderdale

J. A. Whelan
Box 764
Wemlinger, Inc.

Jacksonville

The Cameron & Barkley Co.
605 E. Forsyth St.
Schramm, Inc.
R. H. Johnson
660 College St.
Economy Pumping Machy. Co.
McDonald & Burgman
McCloskey Torch Company
Wallace & Tiernan Co., Inc.
C. H. Eastwood, 408 Hilderbrandt Bldg.

Lake Worth

R. D. Wood & Co.
R. D. Wertz, 113 S. N St.

Miami

Cont. Equipment Co.
2315 N. Miami Ave.
McCloskey Torch Company
Llewellyn Machinery Corp.
1031 N. Miami Ave.
Schramm, Inc.
Railey Milam Hdw. Co.
27 W. Flagler St.
McCloskey Torch Company

Tampa

J. L. Hart Machinery Company
Schramm, Inc.
E. F. Leger
309 Franklin St.
Yeomans Bros. Co.
A. R. Merrill
1202 First National Bank Bldg.
George H. Snell Co.
Ogden Machinery Co.
17th and First Ave.
Wemlinger, Inc.

GEORGIA

Atlanta

R. S. Armstrong & Bros., Inc.
676 Marietta St., N. W.
Wemlinger, Inc.
Burford, Hall & Smith
Red Rock Bldg.
Yeomans Bros.
Wm. J. Neville
Candler Bldg.
Simplex Valve & Meter Co.
Neville & Cleary, Inc.
Candler Bldg.
Automatic Cone Valve Co.
Golden Anderson Valve Spec. Co.
Republic Flow Meters Co.
Tractor & Machinery Co.
351 Whitehall St.
Schramm, Inc.

Columbus

Columbus Iron Works
McCloskey Torch Company

IDAHO

Boise

Howard-Cooper Corp.
Box 1305
Schramm, Inc.

ILLINOIS

Chicago

A. F. Barron
30 N. Michigan Blvd.
Simplex Valve & Meter Co.
G. C. Harnish
Room 532, 9 S. Clinton St.
Peerless Pump Company
Himelblau & Agazim Co.
30 N. Dearborn St.
Automatic Cone Valve Co.
Arthur S. Hindman
1221 First National Bank Bldg.
Columbia Silica Company
O. C. Keckley Co.
565 Washington Blvd.
Golden Anderson Valve Spec. Co.
Republic Flow Meters Co.
Schramm, Inc.
549 W. Washington St.
U. S. Cast Iron Pipe & Foundry Co.
122 S. Michigan Blvd.
Wallace & Tiernan Co., Inc.
180 N. Wacker Drive
Wemlinger, Inc.
228 N. La Salle St.
R. D. Wood & Co.
T. A. Storms, 7243 Jeffrey Ave.

Maywood

Everhot Mfg. Co.
McCloskey Torch Company

Peoria

H. F. Kircher & Co.
Lehman Bldg.
Yeomans Bros. Co.

Rockford

J. P. Adolph
1405 Camp Ave.
Economy Pumping Machy. Co.

INDIANA

Alexandria

Beatson Supply Co.
McCloskey Torch Company

Gary

Republic Flow Meters Co.

Indianapolis

Acme Engineering Agency
Term. Trac. Bldg.
Golden-Anderson Valve Spec. Co.
Barnett-Dunning, Inc.
143 East Ohio St.
Wemlinger, Inc.
Bock Equipment Co.
1900 Northwestern Ave.
Schramm, Inc.
S. E. Fenstermaker & Co.
821 Hume-Mansur Bldg.
Yeomans Bros. Co.
J. A. Graves
923 N. Denny St.
Peerless Pump Company
Hoover Bros. Co.
601 State Life Bldg.
Economy Pumping Machinery Co.
Wallace & Tiernan Co., Inc.
W. A. Hockett, 1004 Fletcher Trust Bldg.

South Bend

Smith-Monroe Co.
1912 S. Main St.
Yeomans Bros. Co.
South Bend Supply Co.
McCloskey Torch Company

Wabash

Roy Wertenberger
308 Eagles Bldg.
George H. Snell Company

IOWA

Davenport

Gierke Robinson Co.
McCloskey Torch Company
D. C. Murphy Co., Inc.
Security Bldg.
Yeomans Bros. Co.

Des Moines

Globe Machinery & Supply Co.
207 W. Court Ave.
McCloskey Torch Company
Peerless Pump Company
C. L. Knehr
521 Hubbell Bldg.
Yeomans Bros. Co.
Stiles-Murray, Inc.
213 Securities Bldg.
Schramm, Inc.
Wickes Eng. & Const. Co.
1441 Bluff St.
Wemlinger, Inc.

Dubuque

F. M. Jaeger Hdw. Co.
768 Main St.
McCloskey Torch Company

Marshalltown

Iowa Municipal Supply Co.
McCloskey Torch Company

Mason City

Mason City Builders Supply Co.
McCloskey Torch Company

Sioux City

The Orcutt Co.
Orcutt Bldg.
McCloskey Torch Company

KANSAS

Kansas City

Industrial Machinery Co.
McCloskey Torch Company

Leavenworth

Reyburn Hardware
S. E. Cor. 5th and Cherokee Sts.
McCloskey Torch Company

Salina

Lee Hardware Co.
McCloskey Torch Company
Salina Supply Co.
McCloskey Torch Company

Topeka

Bowen-Nuss-Brown Hdw.
511-13 Kansas St.
McCloskey Torch Company
Topeka Road & Metal Co.
Schramm, Inc.

Wichita

E. N. Kirwan
220 W. Lewis St.
Schramm, Inc.

KENTUCKY

Lexington

W. C. Sidener
375 Park Ave.
Schramm, Inc.

GEOGRAPHICAL INDEX OF DEALERS AND DISTRIBUTORS

Wallace & Tiernan Co., Inc.
H. N. Jernigan, 424 Kentucky Ave.
B. B. Wilson Co.
139 N. Mill St.
McCloskey Torch Company

Louisville

Dehler Bros.
McCloskey Torch Company
S. E. Fenstermaker & Co.
901 Realty Bldg.
Yeomans Bros.
Lawler Machinery Co.
Starks Bldg.
Schramm, Inc.
Mechanical Equipment Co.
305 Louisville Trust Bldg.
Economy Pumping Machinery Co.
J. F. Shouse & Co.
Starks Bldg.
Automatic Cone Valve Co.

Paducah

Paducah Iron Works
McCloskey Torch Company
H. A. Peter Supply Co.
Schramm, Inc.

LOUISIANA

Monroe

Monroe Hardware Co.
McCloskey Torch Company

New Orleans

E. W. Carr, Inc.
901 Carondelet St.
Economy Pumping Machy. Co.
Walter Castanedo, Inc.
1105 Maritime Bldg.
Yeomans Bros. Co.
Neville & Cleary, Inc.
Union Indemnity Bldg.
Automatic Cone Valve Co.
Golden-Anderson Valve Spec. Co.
Ole K. Olson Co.
Box 68, Station G
Schramm, Inc.
C. T. Patterson Co., Inc.
801 Tchoupitoulas.
McCloskey Torch Company
W. D. Taulman
Union Indemnity Bldg.
Simplex Valve & Meter Co.

MAINE

Camden

J. C. Curtis, Inc.
McCloskey Torch Company

Portland

W. L. Blake Co.
George H. Snell Co.
Ever New Supply Co.
McCloskey Torch Company
Maine Road Equipment Co.
315 Forest Ave.
McCloskey Torch Company
Schramm, Inc.

MARYLAND

Baltimore

Clark & Freeland, Inc.
1503 Hearst Tower Bldg.
Wemlinger, Inc.
W. I. Collier
522 Park Ave.
Economy Pumping Machy. Co.
Morton McI. Dukehart & Co.
Whitaker Bldg.
Yeomans Bros.
John C. Louis Co.
221 S. Eutaw St.
McCloskey Torch Company
John F. Murray
321 Equitable Bldg.
Peerless Pump Company
Wallace & Tiernan Co.
H. F. Cordes, 4807 Norwood Ave.

Hagerstown

Hagerstown Equipment Co.
McCloskey Torch Company

MASSACHUSETTS

Boston

Ames & Campbell
261 Franklin St.
Automatic Cone Valve Co.
The Bond Company
84 High St.
McCloskey Torch Company
Braman Dow & Co.
George H. Snell Co.
Central Equipment Co.
31 State St.
Wemlinger, Inc.
Chas. J. McCarty & Co.
48-50 Pearl St.
McCloskey Torch Company
N. L. C. Engr. & Equip. Co.
101 Tremont St.
Golden Anderson Valve Spec. Co.
New England Implement Co.
19 Jersey St.
Schramm, Inc.
Pierce-Perry Co.
George H. Snell Company
Power Equipment Co.
250 Stuart St.
Yeomans Bros. Co.
Republic Flow Meters Co.
Geo. W. Stetson
141 Milk St.
Simplex Valve & Meter Co.
Sumner & Dunbar
12 Pittsburgh St.
George H. Snell Co.
Waldo Bros. Co.
202 Southampton St.
Sullivan Machinery Co.
Wallace & Tiernan Co.
C. G. Hart, 932 Park Square Bldg.

Cambridge

Dyar Sales & Machinery Co.
McCloskey Torch Company

Fall River

Borden & Remington
McCloskey Torch Company

Lowell

C. B. Coburn Co.
McCloskey Torch Company

Springfield

Holmes & Talcott Co.
McCloskey Torch Company

Worcester

R. D. Wood & Co.
R. M. Simon, 25 Berkmans St.

MICHIGAN

Detroit

American Pump & Supply Co.
General Motors Bldg.
Golden Anderson Valve Spec. Co.
Simplex Valve & Meter Co.
H. J. Clemens
517 E. Larned St.
Economy Pumping Machinery Co.
Contractors Equipment Co.
5163 Martin Ave.
McCloskey Torch Company
Coon DeVisser Co.
2051 W. Lafayette St.
Sullivan Machinery Company
James E. Degan Co.
622 1st St.
Automatic Cone Valve Co.
Earle Equipment Co.
6331 Tireman Ave.
McCloskey Torch Company
Schramm, Inc.
R. G. Moeller Co.
8900 Livernois Ave.
Wemlinger, Inc.
Poe Company
414-420 Curtis Bldg., 2842 W. Grand Blvd.
Peerless Pump Company
Power Plant Supply Co.
739 Fisher Bldg.
Yeomans Bros. Co.
Republic Flow Meters Co.
Wallace & Tiernan Co., Inc.
W. E. Smith
714 Dime Bank Bldg.

Grand Rapids

Barclay, Ayers & Bertsch Co.
321 Bond Ave., N. W.
McCloskey Torch Company
R. E. DeKraker
G. R. National Bank Bldg.
Yeomans Bros. Co.
Kellogg-Burlingame Co.
McCloskey Torch Company
F. D. Lake Co.
16 Campau Ave., N. W.
Schramm, Inc.
F. A. Simonds & Son
301 Peninsula Bldg.
Economy Pumping Machinery Co.

Jackson

Smith-Winchester Co.
McCloskey Torch Company

Kalamazoo

Bond Supply Co.
McCloskey Torch Company

Marshall

Grace Const. & Supply Co.
S. Kalamazoo Ave.
McCloskey Torch Company

MINNESOTA

Crosby

The Crosby Hdw. Co.
McCloskey Torch Company

Duluth

Wm. Constable Company
Providence Bldg.
Peerless Pump Company
Marshall Wells Co.
McCloskey Torch Company
Peter Meagher
329-331 W. Michigan St.
Schramm, Inc.

Minneapolis

Kent Engr. Co.
Builders Exchange Bldg.
Golden-Anderson Valve Specialty Co.
Simplex Valve & Meter Co.
Republic Flow Meters Co.
T. W. Rosholt Co.
McCloskey Torch Company
U. S. Cast Iron Pipe & Foundry Co.
6th and Hennepin Ave.
Wallace & Tiernan Co., Inc.
240 S. Fourth St.

St. Paul

Healy-Ruff Co.
765 Hampden Ave.
Yeomans Bros. Co.
F. T. Hildred & Co.
108 East 3rd St.
Sullivan Machinery Company
O'Connell Supply Co.
356 Cedar St.
Economy Pumping Machinery Co.
Raymer Hdw. Co.
56 East 5th St.
McCloskey Torch Company
A. R. Robertson Co.
1603 University Ave.
Peerless Pump Company

MISSISSIPPI

Jackson

Clifford Waterhouse
McCloskey Torch Company

Yazoo

Yazoo Hardware Co.
McCloskey Torch Company

MISSOURI

Joplin

E. A. Martin Machinery Co.
523 School St.
Schramm, Inc.

Kansas City

Air Made Well Co.
Railway Exchange Bldg.
Sullivan Machinery Company
F. W. Bacharach & Co.
Rialto Bldg.
Automatic Cone Valve Co.
C. H. Carr Company
411 Mutual Bldg.
Peerless Pump Company
Forslund Pump & Machinery Co.
3031 Main St.
Yeomans Bros. Co.
Republic Flow Meters Co.
O. G. Smith
110 E. 40th St.
Simplex Valve & Meter Co.
Steam Plant Equip. Co.
Mutual Bldg.
Golden Anderson Valve Specialty Co.
U. S. Cast Iron Pipe & Foundry Co.
13th and Locust Sts.
Wallace & Tiernan Co., Inc.
223 E. 9th St.

St. Joseph

Bristol Supply Co.
402 Messanie
McCloskey Torch Company

St. Louis

Economy Machy & Equip. Co.
321 S. Grand Blvd.
Economy Pumping Machinery Co.
Fickeissen-Finney Equip. Co.
3620 Laclede Ave.
Schramm, Inc.
Foster Mechanical Equipment Co.
923 Chemical Bldg.
Peerless Pump Company
P. A. Haradon
600 Fullerton Bldg.
Golden Anderson Valve Specialty Co.
Arthur T. Hunter
Railway Exchange Bldg.
Automatic Cone Valve Co.
Lincoln Equipment & Materials Co.
1500 N. Broadway
McCloskey Torch Company
B. H. Mueller
1223 Syndicate Trust Bldg.
Yeomans Bros. Co.
Republic Flow Meters Co.
F. W. Taylor
Paul Brown Bldg.
Wemlinger, Inc.
Wallace & Tiernan Co., Inc.
G. I. Nelson
605 Star Bldg.

Springfield

McGregor Hardware Co.
McCloskey Torch Company

MONTANA

Billings

Midland Implement Co.
McCloskey Torch Company

Butte

Hall-Perry Machinery Co.
802 East Iron St.
Schramm, Inc.

NEBRASKA

Lincoln

Nebraska Mat. Co.
McCloskey Torch Company

Omaha

American Machinery & Supply Co.
1113 Howard St.
McCloskey Torch Company
Fuchs Equipment Co.
1003 Farnum St.
McCloskey Torch Company
Schramm, Inc.
D. E. McCulley Co.
1820 St. Marys Ave.
Yeomans Bros. Co.
North Side Hardware Co.
4112 North 24th St.
McCloskey Torch Company

NEW HAMPSHIRE

Farmington

H. J. Canney
McCloskey Torch Company

Nashua

Johnson-Barker Co.
George H. Snell Company

Summersworth

Brackett & Shaw Co.
Schramm, Inc.

NEW JERSEY

Atlantic City

Atlantic Machinery Supply Co.
1922 E. Riverside Dr.
Schramm, Inc.

Newark

C. H. Loomis & Sons Co.
304 Jelliff Ave.
Schramm, Inc.
Wallace & Tiernan Co.
P. O. Box 178

NEW MEXICO

Albuquerque

Lewis O. Kohlaas
322 S. Terrace Ave.
George H. Snell Company
New Mexico Road Machinery Co.
P. O. Box 665
Schramm, Inc.

NEW YORK

Brooklyn

Jos. G. Pollard Co., Inc.
142 Ashland Place
George H. Snell Co.
John Wilfert Co.
George H. Snell Company

Buffalo

Equipment Sales, Inc.
610 Erie Co. Bank Bldg.
Golden Anderson Valve Specialty Co.
Republic Flow Meters Co.
J. H. Roseberry
1211 Genesee Bldg.
Yeomans Bros. Co.
U. S. Cast Iron Pipe & Foundry Co.
957 E. Ferry St.

GEOGRAPHICAL INDEX OF DEALERS AND DISTRIBUTORS

Wallace & Tiernan Co.
Mr. V. J. Harder
446 Marine Trust Bldg.
The Wheeler-Murray Co.
329-331 Ellicott St.
Schramm, Inc.

Horseheads

George D. Case
Schramm, Inc.

New York

E. E. Brereton
Room 513, 51 E. 42nd St.
Peerless Pump Company
Cont. Trading Co., Inc.
232 Fulton St.
McCloskey Torch Company
A. P. Dienst Company, Inc.
Third Ave. and 140th St.
Schramm, Inc.
Representative for South America
W. R. Grace & Company
P. O. Box 286
7 Hanover Square
Peerless Pump Company
G. W. Hoyns
25 Church St.
Golden Anderson Valve Specialty Co.
Wm. R. James Co.
50 Church St.
George H. Snell Company
E. A. Julie
51 E. 42nd St.
Yeomans Bros. Co.
J. J. McCabe
30 Church St.
Automatic Cone Valve Co.
Public Works Equipment Co.
50 Church St.
George H. Snell Company
Public Works Exchange Corp.
40 Exchange Place
George H. Snell Co.
Republic Flow Meters Co.
Rowland & Burns
39 Cortland St.
Economy Pumping Machinery Co.
W. K. Sowdon
342 Madison Ave.
Simplex Valve & Meter Co.
U. S. Cast Iron Pipe & Foundry Co.
71 Broadway
Wallace & Tiernan Co.
A. M. E. Johnstone
2906 Woolworth Bldg.
Water Works Equipment Co.
50 Church St.
George H. Snell Company

Rochester

Construction Specialties Co.
306 Laburnum Crescent
Economy Pumping Machinery Co.

Syracuse

Miller Equipment Co.
127 Solar St.
Schramm, Inc.
Wallace & Tiernan Co.
L. J. Peck
804 James St.

Troy

The E. I. Van Doren Company
206 Times Bldg.
Yeomans Bros. Co.

NORTH CAROLINA

Ashville

Douglas Co.
George H. Snell Co.

Charlotte

J. R. Purser
406 Commercial Bank Bldg.
Yeomans Bros. Co.
Republic Flow Meters Co.
Wallace & Tiernan Co., Inc.
H. F. Davis
2025 Delworth Road, E.

Fayetteville

Cape Fear Supply Co.
McCloskey Torch Company

Greensboro

J. D. Wilkins
W. Lee St. at Glenwood Ave.
McCloskey Torch Company
Schramm, Inc.

Raleigh

Dillon Supply Co.
McCloskey Torch Company

Winston-Salem

Atlas Supply Co.
George H. Snell Co.

OHIO

Akron

Hardware & Supply Co.
475 S. High St.
McCloskey Torch Company

Canton

Quality Hardware Co.
McCloskey Torch Company

Cincinnati

O. J. Allonier
1231 Union Trust Bldg.
Yeomans Bros. Co.
Geist & Murphy
309 Main St.
Economy Pumping Machinery Co.
Hauer Power Equipment Co.
Union Trust Bldg.
Golden Anderson Valve Specialty Co.
Wm. T. Johnston Co.
214 Vine St.
Schramm, Inc.
Republic Flow Meters Co.

Cleveland

Bacon-Hibbard-Eichman, Inc.
917 Central Ave.
Schramm, Inc.
Cleveland Pump & Supply Co.
418 Rockefeller Bldg.
Yeomans Bros. Co.
H. W. Jarrett
Rockefeller Bldg.
Golden Anderson Valve Specialty Co.
Republic Flow Meter Co.
Tomlinson, MacLachlan, Inc.
1601 St. Clair Ave.
Simplex Valve & Meter Co.
U. S. Cast Iron Pipe & Foundry Co.
1150 E. 26th St., N. E.
Wallace & Tiernan Co., Inc.
810 Perry-Payne Bldg.
Wilson & Young
1856 Euclid Ave.
Wemlinger, Inc.

Columbus

E. W. Hawke
297 S. High St.
McCloskey Torch Company
Shartle Machine Co.
359 Dublin Ave.
Golden Anderson Valve Specialty Co.
C. L. Stith Co.
305 Franklin St.
McCloskey Torch Company
The Taylor Tractor Co.
McCloskey Torch Company
Wallace & Tiernan Co., Inc.
Mr. F. P. Fisher
111 E. Norwich Ave.
The W. W. Williams Co.
987 W. Goodale St.
Schramm, Inc.
W. W. Williams Co.
624 Webster St.
Schramm, Inc.

Dayton

Kelso-Wagner Co.
134 W. 2nd St.
Yeomans Bros. Co.

Elyria

Farm Implement Co.
328 Broad St.
McCloskey Torch Company

Lakewood

R. B. Wood & Co.
Vincent McCarthy
1256 Elbur Ave.

Newark

Crane-Krieg-Flory Co.
McCloskey Torch Company

Portsmouth

The Industrial Supply Co.
1515 Tenth St.
Wemlinger, Inc.

Toledo

Bostwick-Braun Co.
Cor. Summit & Monroe Sts.
McCloskey Torch Company
Contractors' Machinery Co.
909 Summit St.
McCloskey Torch Company
W. A. Kuhlman & Co.
340 Water St.
McCloskey Torch Company
Moriarty Bros.
208 Knapp St.
Wemlinger, Inc.
National Supply Co.
P. O. Box 899
McCloskey Torch Company
A. Carle Rogers
752 Euclid Ave.
Yeomans Bros. Co.
Toledo Sales & Engineering Co.
16 N. St. Clair St.
Schramm, Inc.

OKLAHOMA

Oklahoma City

The Boardman Co.
McCloskey Torch Company
Leland Equipment Co.
Schramm, Inc.
Frank Loeffler Supply Co.
710 N. Hudson St.
Economy Pumping Machinery Co.
J. D. Mann Const. Co.
618 Petroleum Bldg.
McCloskey Torch Company
W. J. Pettee & Co.
McCloskey Torch Company
Wallace & Tiernan Co., Inc.
Mr. E. W. Schouten
619 Cotton Exchange Bldg.
Wylie Bros.
McCloskey Torch Company

Tulsa

Leland Equipment Co.
515 W. Archer St.
McCloskey Torch Company
Leland Truck Equipment Co.
30 North Owasso St.
Schramm, Inc.

OREGON

Portland

Consolidated Supply Co.
George H. Snell Co.
M. Donald Spencer
355 Everett St., cor. Eighth St.
Peerless Pump Co.
Gordon & Finkbeiner
222 Pine St.
Yeomans Bros.
Howard-Cooper Corp.
Third and Hawthorne Sts.
Schramm, Inc.
J. L. Latture Equipment Co.
McCloskey Torch Company
Republic Flow Meters Co.
Wm. S. Turner & Co.
Pacific Bldg.
Golden Anderson Valve Specialty Co.

PENNSYLVANIA

Corry

Corry Bridge & Supply Co.
McCloskey Torch Company

Erie

A. H. Brebner & Son
14 East 5th St.
McCloskey Torch Company

Pen Argyl

Quarry Supply Company
Sullivan Machinery Company

Philadelphia

A. R. Amos, Jr.
502 Harrison Bldg.
Yeomans Bros. Co.
G. R. Chambers
Bourse Bldg.
Economy Pumping Machinery Co.
DeHuff & Hopkins
Morris Bldg.
Automatic Cone Valve Co.
Edwin Elliot & Co.
560 N. 16th St.
Golden Anderson Valve Specialty Co.
N. E. Henderson & Son
1320 Race St.
McCloskey Torch Company
Republic Flow Meters Co.
Service Supply Corp.
20th and Venango Sts.
McCloskey Torch Company
U. S. Cast Iron Pipe & Foundry Co.
1421 Chestnut St.
Wallace & Tiernan Co.
Mr. J. B. Kinney
137 S. 50th St.

Pittsburgh

C. C. Behney
718 Empire Bldg.
Simplex Valve & Meter Co.
George H. Snell Company
Bradshaw & Co.
530 Fourth Ave.
Automatic Cone Valve Co.
Bushnell Machinery Co.
1501 Grant Bldg.
Yeomans Bros. Co.
James T. Castle
1601 Arrott Bldg.
Peerless Pump Company
Dravo Equipment Co.
McCloskey Torch Company
Leiendecker Bros.
Fulton Bldg.
Economy Plumbing Machinery Co.
Republic Flow Meters Co.
Schramm, Inc.
331 Fourth Ave.
U. S. Cast Iron Pipe & Foundry Co.
6th and Smithfield Sts.
Wallace & Tiernan Co., Inc.
233 Oliver Ave.
Geo. W. Ziegler Machy. Co.
528 First Ave.
Schramm, Inc.

Reading

Geo. D. Lessig & Son
South Temple
Schramm, Inc.

Sharon

Fruit-Ohl Co.
84 E. State St.
McCloskey Torch Company

Wilkes-Barre

P. F. Gilboy
Bennett Bldg.
Economy Pumping Machinery Co.
Lewis & Bennett Hdw. Co.
McCloskey Torch Company

RHODE ISLAND

Pawtucket

Gallagher & Mooney
318 Main St.
McCloskey Torch Company

Providence

Congdon & Carpenter
McCloskey Torch Company

SOUTH CAROLINA

Columbia

Columbia Supply Co.
823 W. Gervais St.
McCloskey Torch Company
Construction Equipment Company
1213 Lincoln St.
Schramm, Inc.

Greenville

R. P. Sweeny Co.
Chamber of Commerce Bldg.
McCloskey Torch Company
Wemlinger, Inc.

SOUTH DAKOTA

Rapid City

Evans Tractor & Equipment Co.
McCloskey Torch Company
Sullivan Machinery Company

Sioux Falls

Western Material Co.
McCloskey Torch Company

TENNESSEE

Chattanooga

McWhorter Truck & Equipment Co.
300 West Main St.
Schramm, Inc.
Wallace & Tiernan Co., Inc.
Mr. G. R. Kavanagh
634 Tennessee Power Bldg.

Knoxville

Iddins Machinery Company
111 East Jackson St.
Schramm, Inc.
Wallace & Tiernan Co., Inc.
Mr. A. R. Murphy
1214 Holston Bank Bldg.

Memphis

Carloss Well Supply Co.
1116 Front St.
Sullivan Machinery Company
Hoshall Machinery Co.
715 Fidelity Bank Bldg.
Yeomans Bros. Co.
Tri-State Equipment Co.
393 North Main St.
Schramm, Inc.
Sullivan Machinery Company

GEOGRAPHICAL INDEX OF DEALERS AND DISTRIBUTORS

Nashville

Harvill Supply Co.
413 Commerce St.
Schramm, Inc.
Jones & Allen Co., Inc.
111 First Ave., S.
Sullivan Machinery Company

TEXAS

Amarillo

D. L. McDonald
717 Amarillo Bldg.
Peerless Pump Company

Dallas

Browning Ferris Machinery Co.
McCloskey Torch Company
F. C. Crane Company
1301 S. Lamar St.
Schramm, Inc.
C. M. Crookshank
1315 Santa Fe Bldg.
Golden Anderson Valve Specialty Co.
Dillard-Lewis Co.
612 Construction Industries Bldg.
Yeomans Bros. Co.
Republic Flow Meters Co.
Smith & Courtney
2507 Commerce St.
Sullivan Machinery Company
Smith & Whitney
2017 Cedar Springs Rd.
Economy Pumping Machinery Co.
U. S. Cast Iron Pipe & Foundry Co.
Akard and Commerce Sts.
Wallace & Tiernan Co., Inc.
506 Central Bank Bldg.

El Paso

Geo. W. Herlin
1520 Campbell St.
Yeomans Bros. Co.
Francis Wagner
307 San Francisco St.
Schramm, Inc.

Houston

J. R. Christian Co.
1601 Post-Dispatch Bldg.
Wemlinger, Inc.
M. N. Dannenbaum
Bankers Mortgage Bldg.
Simplex Valve & Meter Co.
F. W. Gartner & Co.
3135 McKinney Ave.
P. O. Box 1303
McCloskey Torch Company
Schramm, Inc.
C. C. Saner
703 Keystone Bldg.
Sullivan Machinery Company
S. Texas Imp. & Machinery Co.
Wood & Jacinto
McCloskey Torch Company
Texas Engineering Co.
941 Electric Bldg.
Yeomans Bros. Co.

San Antonio

Alamo Iron Works Co.
30 Santa Clara St.
McCloskey Torch Company
Schramm, Inc.
Dillard-Lewis Co.
Yeomans Bros. Co.

UTAH

Ogden

Wallace & Tiernan Co., Inc.
Mr. L. W. Pingree
427 Kiesel Bldg.

Salt Lake City

Hawley-Richardson-Williams Co.
Dooly Bldg.
Yeomans Bros. Co.
Republic Flow Meters Co.
Water Works Equipment Co.
149 W. 2nd South St.
Simplex Valve & Meter Co.

VIRGINIA

Petersburg

R. D. Wood & Co.
P. G. Bunting
108 S. Syracuse St.

Richmond

Hackley Morrison Co., Inc.
204 N. Jefferson St.
Wemlinger, Inc.
Richmond Machinery & Equip. Co.
12-14-16 North 15th St.
Schramm, Inc.
Virginia Engineering Co.
American Nat. Bank Bldg.
Automatic Cone Valve Co.

Roanoke

Wallace & Tiernan Co.
Mr. J. M. Masterson
318 Mountainview Terrace

WASHINGTON

Seattle

E. R. Bracken
Pantages Bldg.
McCloskey Torch Company
Republic Flow Meters Co.
Steam Appliance Co.
415 Lenora St.
Yeomans Bros. Co.
U. S. Cast Iron Pipe & Foundry Co.
1st and Marion Sts.
Wallace & Tiernan Co., Inc.
Mr. Emerson Dolliver
411 Lloyd Bldg.
Water Works & Power Equip. Co.
White-Henry-Stuart Bldg.
Automatic Cone Valve Co.
Goldern Anderson Valve Specialty Co.
Simplex Valve & Meter Co.

Spokane

Spokane Hardware Co.
McCloskey Torch Company
Wallace & Tiernan Co., Inc.
Mr. Lawrence Sovulewski
724 Realty Bldg., 224 Riverside Dr.

Tacoma

Washington Hardware Co.
McCloskey Torch Company

WEST VIRGINIA

Charleston

Capitol Cy. Supply Co.
McCloskey Torch Company
Capitol Equip. Co.
Bank of Commerce Bldg.
Golden Anderson Valve Specialty Co.
Wallace & Tiernan Co., Inc.
Mr. R. C. Clement
309 Ruffner Ave.
Loewenstein & Sons
McCloskey Torch Company

Huntington

Banks Miller Supply Co.
McCloskey Torch Co.

Parkersburg

Parkersburg Supply Co.
McCloskey Torch Company

Wheeling

Kennedy Hardware Co.
McCloskey Torch Company

WISCONSIN

Milwaukee

Boehck Machinery Co.
2406 Clybourn St.
McCloskey Torch Company
Chadwick Bros. Co.
25th and Clybourne Sts.
McCloskey Torch Company
Cunningham-Ortmayer Co.
15 Michigan St.
McCloskey Torch Company
F. H. Dorner
311 Knapp St.
Simplex Valve & Meter Co.
Geo. F. Fredericks Co.
216 Water St.
Automatic Cone Valve Co.
Kolloge Hardware Co.
3rd St. at Juneau
McCloskey Torch Company
Chas. W. Miller
194 Reed St.
Yeomans Bros. Co.
Republic Flow Meters Co.

WYOMING

Casper

Nicolaysen Lbr. Co.
McCloskey Torch Company

CANADA

Brantford, Ont.

Jordan Roberts Sales Ltd.
Peerless Pump Company

Calgary, Alta.

Bell & Morris
McCloskey Torch Company

Cobalt, Ont.

Northern Canada Supply Co.
McCloskey Torch Co.

Montreal

Darling Brothers, Ltd.
Yeomans Bros. Co.
Engineering Equipment Co.
1072 Beaver Hall Gill
Economy Pumping Machinery Co.
F. Hankin Co., Ltd.
2028 Union Ave.
Simplex Valve & Meter Co.
Mussens, Ltd.
Phillips Place Bldg.
McCloskey Torch Company

Sault Ste. Marie, Ont.

J. M. Biscomb
673 Queen St.
McCloskey Torch Company
Toronto
Darling Bros., Ltd.
Yeomans Bros. Co.
F. Hankin & Co., Ltd.
165 Spadina Ave.
Simplex Valve & Meter Co.
Wallace & Tiernan Co., Inc.
Mr. J. Van Benschoten
Foy Bldg., 32 Front St.

Vancouver, B. C.

Brown-Fraser Co., Ltd.
1150 Homer St.
Schramm, Inc.
Frank Darling & Co.
1142 Homer St.
Yeomans Bros. Co.

Winnipeg

Darling Brothers, Ltd.
Yeomans Bros. Co.
Powell Equipment Co.
1056 Arlington St.
McCloskey Torch Company
Wallace & Tiernan Co., Inc.
Mr. H. C. Lindsten
813 Royal Bank Bldg.

CUBA

Havana

Daniel, Inc.
814 Metropolitana Bldg.
Simplex Valve & Meter Co.
Purdy & Henderson Trading Co.
Havana 55, esquina a Empedrado
Yeomans Bros. Co.

HAWAII

Honolulu

Honolulu Iron Works
Yeomans Bros. Co.

FOREIGN REPRESENTATIVES

ARGENTINA

Buenos Aires

Buxton, Guilayan & Co., Ltd.
Yeomans Bros.

AUSTRALIA

Melbourne

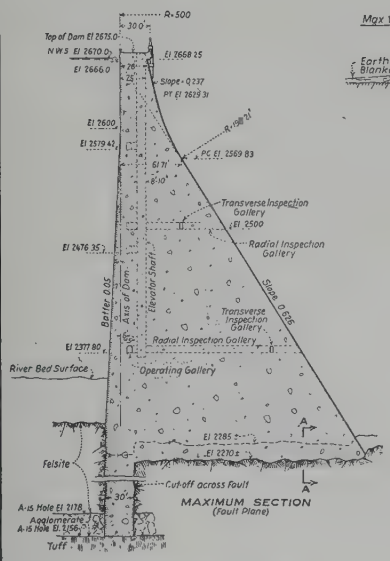
Gibson, Battle (Melbourne) Pty., Ltd.
Yeomans Bros. Co.

JAPAN

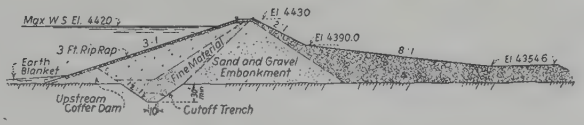
Tokio

Okura & Co.
Yeomans Bros. Co.

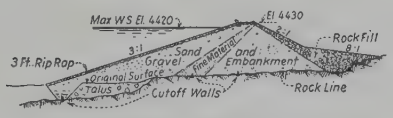
Sections of U. S. Reclamation Service Dams



OWYHEE DAM
OREGON
CONCRETE ARCH-GRAVITY TYPE
MAX. HT. = 405 FT.

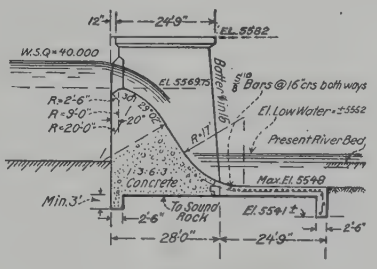


MAXIMUM SECTION OF DAM



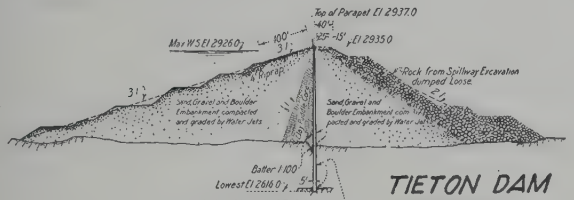
TYPICAL ABUTMENT SECTION

GUERNSEY DAM
WYOMING
EARTH & ROCK FILL TYPE
MAX. HT. = 105 FT.



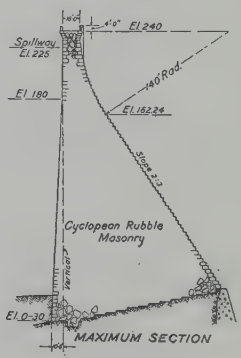
SECTION OF SPILLWAY

COLORADO RIVER ROLLER DAM
COLORADO
MAX. HT. = 24 FT.

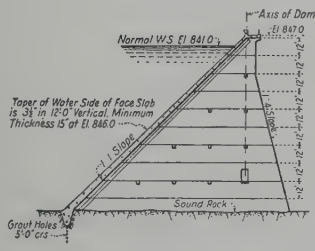

Top of Parapet El 2937.0
El 2935.0
Max W.S El 2926.0
Rock from Spillway Excavation dumped Loose
Sand Gravel and Boulder Embankment compacted and grated by Water Jets
Batter 1:100
Lowest El 2846.0
TYPICAL SECTION OF DAM
Reinforced Concrete Corewall carried not less than 10' into sound Rock or Shale

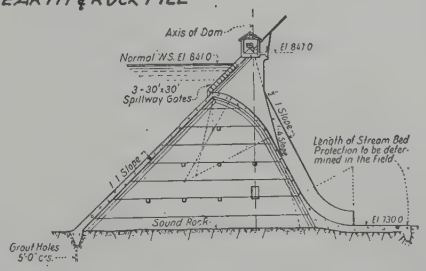
TIETON DAM
WASHINGTON
EARTH & ROCK FILL

WIND RIVER DAM
WYOMING
CONCRETE WEIR, EARTH EMBANKMENT

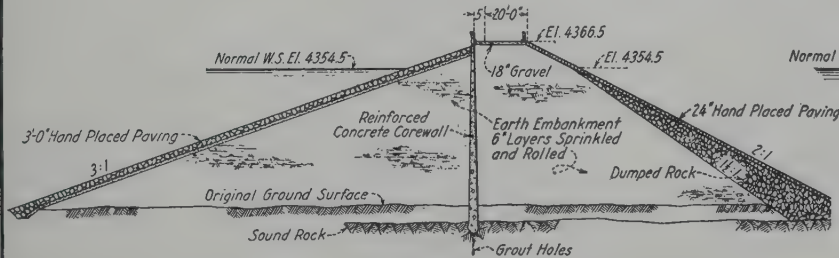


ROOSEVELT DAM
ARIZONA
MASONRY, ARCHED GRAVITY TYPE
MAX. HT. = 280 FT.

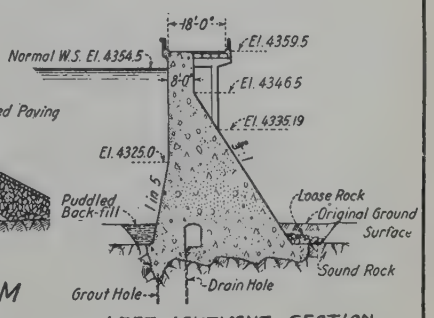

Axis of Dam
El 847.0
Normal W.S. El 841.0
Taper of Water Side of Face Slab is 3½" in 12'-0" Vertical. Minimum Thickness 15" at El. 846.0
1:1 Slope
Sound Rock
Grout Holes 5'-0" crs



TWO SECTIONS OF STONY GORGE DAM
CALIFORNIA - AMBURSEN TYPE - MAX. HT. = 125 FT.



MAXIMUM SECTION, RIGHT EMBANKMENT



AMERICAN FALLS DAM
IDAHO

LEFT ABUTMENT SECTION

Grouting of Dams, Tunnels, Shafts, Etc.

The merits of grouting for the pretreatment of damsites and for the sealing of leakages have been recognized by engineers for many years.

Ordinary Processes.—Grouting is usually carried on by forcing the fluid grout into the voids to be filled by means of gravity or by air pressure. Where fine material is being dealt with, two pipes are driven a short distance apart. Water is pumped down one pipe, and the stream finds its way through the voids or fissures below the surface to the second pipe, through which it escapes to the surface. Once a channel has been formed in this way, cement grout is forced through the same path until grout appears in the outlet pipe. This pipe is then sealed and the effect of further pumping is to force the grout into the material adjacent to the channel, forming a dense, solid deposit of concrete. The deposit may be built up in any direction by driving the pipes at different locations and to different elevations.

Where the material to be grouted is not firmly compacted, or where the voids form a fairly large percentage of the whole, the grout may be introduced simply by driving a row of pipes and pouring the mixture into them. In this case the head furnished by the grout itself will be sufficient to force it through the permeable material. The chief difficulty in grouting coarse material lies in keeping the grout from spreading too far from the point of introduction, or beyond the confines of the territory it is wished to solidify. In the event such conditions are met with, the grout should be introduced a little at a time and the successive accretions allowed to set before more is placed. Thus a shell partially enclosing the region to be grouted is built up, and the deposit may be completed with as much rapidity as the grout will flow away through the interstices of the material.

Dry grouting of sand has been experimented with, but this scheme is seldom employed at present. This process requires a pipe, drawn to a point at the lower end, which is perforated with holes about ⅜ in. in diameter. The pipe is connected to a source of compressed air at its upper end, and cement is fed into the pipe by means of an injector. The cement is carried into the sand through the holes in the pointed end of the pipe, where the action of the escaping air is to mix sand, cement and water into a mortar which solidifies into a firm mass. The grouted region is extended by raising the pipe and by moving it to a new location.

Francois Cementation Process.—This process was developed by Albert Francois and the Francois Cementation Co., of London, operates under his patent. The term "cementation" denotes movement of the grouting mixture directly by means of pump pistons. Compressed air is not used, and the liquid cement is carried by the extremely high pressures under which it is driven, into the finest fissures and cracks in such a way as to unite the materials into an impermeable mass.

The pumps used are capable of quickly developing pressures up to 3,000 lb. per square inch. The cement column is moved continuously, and it is claimed that control is simple and flexible. The cement tanks and pumps may be located hundreds of feet away from the point of application, resulting in few movements of the plant while a wide territory is being covered. Chemicals are employed as lubricants to insure the carrying of the grout into the finest fissures and cracks.

The methods of the Francois Cementation Co. are the result of many years' study of the problem of cement grouting. They are responsible for the repairs to St. Paul's Cathedral in London and the foundation treatment of the famous Leaning Tower of Pisa. In addition they have treated dam sites all over Europe and have corrected defects in many existing dams. The Francois has also been found efficacious in sealing leakages in shafts and tunnels, as well as in the pre-treatment of strata to permit dry excavation, and the strengthening of foundations to prevent vibration and subsidence has been repeatedly carried out.

By means of an arrangement with the Francois Cementation Co., the Dravo Contracting Co., of Pittsburgh, Pa., is granted the use of the Francois patents on this continent. A staff skilled in the application of the process has joined the Dravo organization, under the direction of Maj. J. S. Crawhall, who has had charge of some of the largest cementation shaft-sinking jobs in England. A number of application of the Francois process have already been made in this country.

Asphalt Grouting.—A process of grouting employing liquid asphalt has been developed by George W. Christians, a Chattanooga, Tenn., engineer. This method is practiced, under patents, by the American Asphalt Grouting Co. of Chattanooga.

The principle of operation involved in asphalt grouting is the pumping of a material which is fluid when hot, but not absolutely solid when cooled—such as asphalt—down through electrically heated pipes placed in drilled holes, into the crevices in the rock below. When the asphalt leaves the pipe and touches the water it congeals on the outside into a nearly solid condition. In this state it is tough enough to resist the pressure of a moving stream of water, but soft enough so that a moderate pressure from the pipe line can expand it from the inside until it fills and effectually seals the crevices against the flow of water.

It is necessary that the material be an insulator of electricity, a poor conductor of heat and insoluble in water. It must melt at a moderate temperature and when cold it must be stiff enough to resist whatever water pressure may be encountered. At the same time it must be ductile enough so that a heavier pressure from the pipe line will slowly expand it into the crevices so as to make intimate contact with the rock surfaces. Asphalt fulfills all of these requirements very well. In addition, when so placed it is as permanent as the rock itself.

The apparatus required is simple and inexpensive. A heating kettle for melting the asphalt and a small, adjustable-stroke piston pump driven by a 1-hp. motor are required for handling the asphalt to the pipe line. The pipe is usually 1½ in. extra heavy throughout the upper portion, while that in the crevice-bearing rock is 1½-in. standard weight pipe perforated by ¾-in. holes. It is heated by an iron resistance wire which enters through an insulated stuffing box at the top and is held in the center of the pipe by suitable insulators at the pipe couplings. The wire is fastened electrically and mechanically to the pipe at the bottom. The electrical circuit passes down the wire and back up the pipe. The wire is kept taut by tension springs at the top. As mentioned above, patents have been secured covering the method and apparatus.

In operation the pipe may be surrounded by water and thereby kept so cool that the asphalt touching it is solid. However, the heat conductivity of the asphalt is such that a fluid passage is easily maintained next to the hot wire in the center so that the pressure is equalized from top to bottom of the pipe. The asphalt is free to emerge at any of the several cavities which may exist throughout the extent of the perforations, and when back pressure is built up, a definite assurance is obtained that all crevices encountered by this hole are filled.

The heating device not only keeps the asphalt in a fluid condition until it reaches the cavities to be filled, but also makes it possible to resume operations after a shutdown merely by applying the heat for a few minutes before starting the pump.

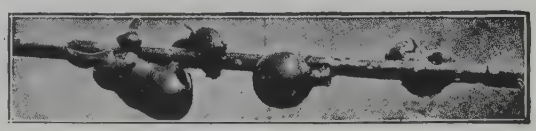
THE AMERICAN ASPHALT GROUTING CO.

Chattanooga, Tennessee

Licensed under Christians Asphalt Grouting Patents

European licensee: FRANCOIS CEMENTATION CO., Ltd., Doncaster, England

Leakage of water through rock, masonry, concrete, gravel, etc., can be stopped more surely and economically by Asphalt Grouting than by any other method.



Asphalt Emerging from Pipe

Hot fluid asphalt is pumped through electrically heated pipes placed in drilled holes intercepting the cracks or crevices to be filled. When the asphalt leaves the pipe and touches the water it congeals on the outside into a nearly solid condition which is tough enough to resist the pressure of a moving stream of water, but soft enough so that a moderate pressure from the pipe line can expand it from the inside until it fills and effectually seals the crevice against the flow of water.

This process has been applied successfully to a number of difficult and important jobs during the past four years; and all operating problems thoroughly worked out. Some outstanding advantages of Asphalt Grouting are:

(1) Holes can be drilled to full depth in one operation through any number of cavities.

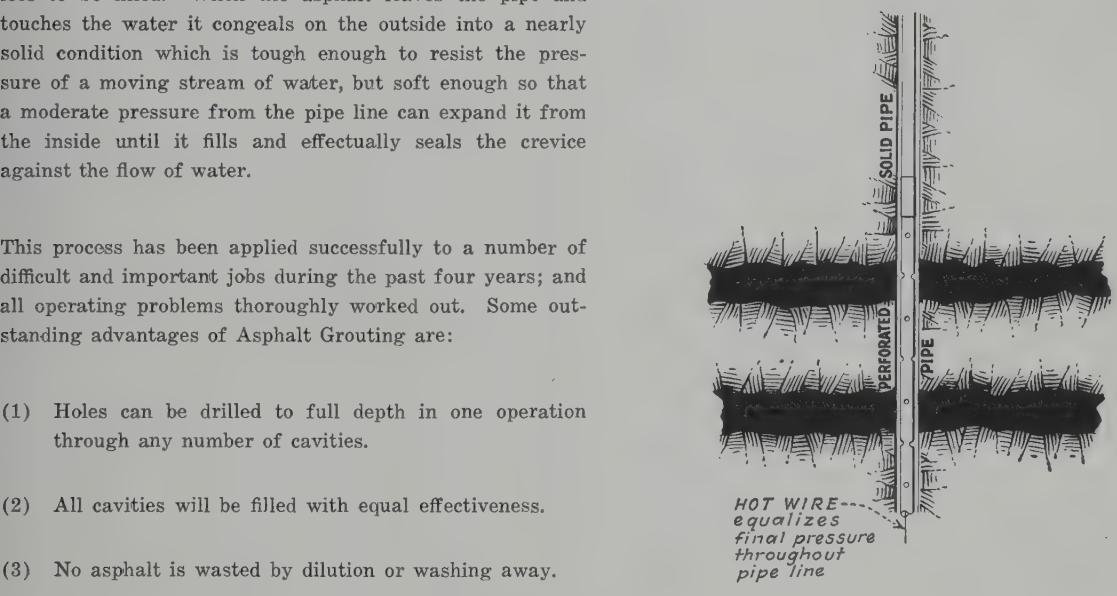
(2) All cavities will be filled with equal effectiveness.

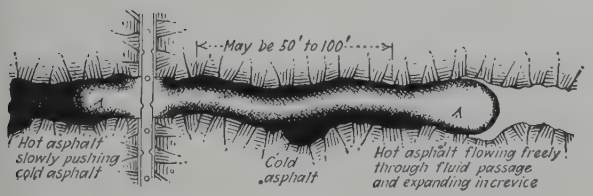
(3) No asphalt is wasted by dilution or washing away.

(4) Movement of asphalt away from pipe line is ample, but easily controlled, so that closure is effected with minimum excess material.

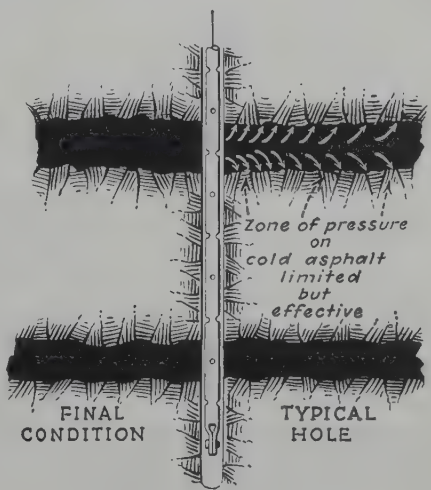
(5) Final pressure gives absolute assurance that all cavities pierced by the drilled hole are filled.

Further information on request




May be 50' to 100'
Hot asphalt slowly pushing cold asphalt
Cold asphalt
Hot asphalt flowing freely through fluid passage and expanding in crevice

Hot Asphalt Expanding in Typical Crevice



Trenching by Machine and by Hand

Excavating with Small Trenching Machine

The following comparison of costs by machine and hand methods was given by H. S. Greene, Vice-President, Barber-Greene Co., in a paper presented at the 1928 convention of the American Water Works Association:

A small trench machine is a machine to cut about 24 in. wide and capable of digging from 6 to 8 ft. deep.

Advantages of Small Machines.—The need of a small trench machine is much more apparent today than it was several years ago. Then all mains were placed in the roadway, but today many engineers are recommending that they be put in parkways or alleys. Where this practice is followed, the small machine is the answer for excavating ditch. There is also another factor which influences one to consider the small machine, and that is the shortage of common labor. A small trench machine will do the work of 30 to 50 men.

The small machine was originally designed for city conditions, but is able to give a very good account of itself on long distance cross-country work, where the machine is quite often operated 24 hours per day and where dependability is a matter of prime importance.

Cost of Operation.—Having considered the general specification of a small trench machine, the next problem is to analyze the cost of digging ditch. Results submitted by scores of users indicate a wide variety of methods in securing costs. For example, in the matter of depreciation, one contractor insists on writing off the whole cost of the ditcher on his first job. Occasionally a public utilities organization will take the opposite extreme and figure a 15-year life. Perhaps an average of these two is a fair depreciation and may be taken as five years.

In the item of interest on the investment, there is not much variation, as 4 per cent of the purchase price extending over the life of the machine is close enough for practical purposes.

Repairs can be determined with some accuracy by examining records for previous years, but any estimate for the coming season is at the best merely a guess. It is possible, however, to determine some sort of average from various reports which have been turned in by the owners of small machines. Expressed as a percentage of the purchase price, this can be used in estimating the cost of future work, assuming that no serious accidents will be encountered which will run the repairs beyond the average. This item should include the cost of all parts purchased, the cost of machine shop work, the cost of work by mechanics other than the operator, and even the cost of the operator's time when the work is done between jobs. This item should not include the operator's time for making ordinary adjustments or replacement of parts on the job, because his time will show straight through as that of the operating expense. As near as can be estimated, the repairs on a small machine, including the digging teeth, may be expected to run from 8 to 14 per cent of the purchase price.

An estimate based on a 5-year life carrying 6 per cent interest on the investment, including repairs of 12 per cent, will figure about $15 per day. This can be said to represent the overhead expense of operating a small machine. The daily operating expense, of course, can be determined exactly, using the operator's wages, plus gasoline and lubricating oil. In many conditions, a helper will increase the amount of ditch dug per day sufficiently to pay his wages many times over. Gasoline consumed will vary from 1 to 2½ gal. per hour, and oil and grease might be said to be a dollar a day. This is very liberal, and from these it will be found that the total operating charge per day will be about $10, or possibly a little higher is a helper is used. This makes the total cost for operating a machine about $25, or possibly $30 per day.

In reducing these figures to a cost-per-foot basis, the most important item, of course, is the amount of trench dug per day. This may vary through a very wide range. The amount of trench dug per day may be limited by the laying of pipe, and the amount dug will also vary on account of material. For example, 400 ft. in a caliche formation might be considered a good day's work, whereas 6,000 ft. a day in top soil is possible where the digging is easy and only 30 in. deep. Between these two extremes there is such a variety of widths, depths, and conditions of soil that an expert would have to be called in if it is desired to have a fairly close estimate of cost in advance. Even then there may be a large discrepancy between the estimate and the actual costs, due to the difficulty of determining the conditions underground.

After varying the different factors to meet local conditions, the worst circumstances give $35 per day to operate a small machine. Assuming that only 500 ft. of trench is dug per day, the cost would be 7 ct. per foot. After checking this up with actual cost records submitted by various water-works organizations, a fairly close relation is noted.

Costs on Specific Jobs.—One machine working in San Antonio cut ditch at a cost of 5 ct. per feet. This was in a particularly hard formation, where even with cheap Mexican labor, hand work cost 40 ct. per foot. In Houston, a trench 21 in. wide and 5½ ft. deep cost 7 ct. per foot. In Oakland, Calif., a ditch 18 in. wide and 3½ ft. deep was cut for 4½ ct. per foot. In Chicago, Ill., a ditch 18 in. wide and 4½ ft. deep was cut for 4½ ct. per foot. In Shreveport, La., a ditch 18 in. wide and 5½ ft. deep was cut for 5½ ct. per foot.

In Norman, Okla., the machine paid for itself in cutting 34,000 ft. charged at 10 ct. per foot for all of the work. This machine also did work for the sewer department, gas company and telephone company. The city of Thomasville, Ga., reports costs as low as 2¾ ct. average for water ditch, and 4½ ct. per foot for sewer ditch.

Cost Per Cubic Yard.—Converting lineal foot costs to costs per cubic yard gives interesting information. Some records of cross-country work show 5 ct. per yard but, of course, this is an extreme. Again, records show costs as high as $1.16 per yard, but one might assume something was wrong here. After checking a large number of records and

Cost of Excavating Small Ditches, Machine Versus Hand Method

	Location and Nature of Soil	Width of Trench in In.	Depth of Trench in In.	Total Job Footage	Total Cost	Trench Cost per Foot	Hand Work Cost per Foot	Saving per Foot	Total Saving	Remarks
1	Streets, all kinds of soil	12	42	56,231	.....	$0.063	.....	.....	.....	Average for
2	Streets, all kinds of soil	12	42	176,076	.....	.065	.....	.....	.....	3 machines
3	Streets, very rocky.....	18	44	35,047	.....	.081	.....	.....	.....	Gas Co.
4	Streets, very rocky.....	16	48	18,570	.....	.051	.....	.....	.....	Telephone
5	Streets and parkways, hard-pan and clay.....	18	60	100,000	.....	.075	.....	.....	.....	Water
6	Boulders, clay and sand	18	48	110,415	.....	.038	.....	.....	.....	
7	Hard-pan	....	....	39,000	.....	.072	.....	.....	.....	Water
8	In parking, no hard dirt	18	42	9,110	$463.09	.05	$0.22	$0.17	$1,169.51	.....
9	In parking, no hard dirt	18	48	456	28.34	.08	.23	.15	53.03	.....
10	In parking, no hard dirt	18	66	200	18.89	.09	.38	.29	57.92	.....
11	In parking, no hard dirt	18	60	325	20.14	.06	.32	.26	84.22	.....
12	In parking, no hard dirt	18	38	1,553	109.52	.07	.26	.19	290.04	.....
13	Surfaced street, loam....	18	42	2,451	104.28	.04	.19	.14	354.80	.....
14	Paved street, loam.....	18	36	104	8.68	.04	.16	.13	13.37	.....
15	Unsurfaced, hard dirt....	18	42	3,850	222.32	.08	.20	.12	344.56	.....
16	Unsurfaced, hard dirt....	18	48	424	25.14	.06	.19	.13	57.04	.....
17	Surfaced, hard dirt.....	18	42	1,229	139.11	.11	.19	.08	99.69	.....
18	Surfaced, hard dirt.....	18	48	233	29.86	.13	.32	.19	45.32	.....
19	Surfaced, hard dirt.....	18	60	100	14.55	.15	.34	.19	19.36	.....
20	Surfaced, hard dirt.....	18	42	4,261	459.32	.10	.27	.17	665.27	.....
21	Paved street, hard dirt	18	36	195	19.71	.10	.19	.09	18.06	.....
22	Surfaced, rocky soil.....	18	42	693	64.01	.09	.33	.24	160.99	.....
23	Surfaced, hard dirt.....	18	42	209	24.66	.12	.32	.20	43.20	.....
24	Resurfaced, rocky soil....	18	42	700	57.20	.08	.32	.24	169.88	.....
25	Paved street, hard dirt..	18	48	363	28.94	.08	.22	.14	49.47	.....
26	Paved street, hard dirt..	18	42	424	37.33	.09	.32	.23	99.81	.....
27	In parking, no lawn, rocky soil	18	42	164	12.70	.08	.32	.24	40.49	.....
28	In parking in lawn, rocky soil	18	48	397	31.06	.08	.19	.11	44.08	.....
29	In parking in lawn, rocky soil	18	42	300	20.21	.07	.22	.15	44.73	.....
30	In parking in lawn, hard dirt	18	48	231	22.35	.09	.21	.12	27.20	.....

omitting from the summary those that were incomplete, the cost is about 25 ct. per cubic yard for excavation.

Results Obtained.—Whether users, in figuring the probable cost of work in advance, follow the percentages and unit costs outlined above more or less closely, is not known, but certainly, reports indicate that in figuring the cost of jobs after completion of the work these users deviate quite markedly.

In the matter of interest, it is found that users are quite likely to figure 6, 7 or 8 per cent of the total purchase price; at least for the first year, instead of taking an average over the life of the machine and figuring 4 per cent on the purchase price.

The total overhead as reported by the various users shows very little variation, running from $10.30 per day to $12.20 per day, with the exception of one user who placed a heavy depreciation against a 70-day job. This makes the overhead total $19.16 per day.

Under the heading of operating expense, the results of four users agree very closely, varying from $7.16 to $8.09 per day. Two other users show $12.65 and $12.91 per day and in one of these cases it is known that the high rate is due to the fact that the operator and helper were permitted to remain idle when the machine was not digging, or in case they were put on other work, their pay was still charged against the ditching job. The figures indicate that on city work the ditchers are idle about one-third of the time, waiting for the pipe-laying gang to catch up, or for other reasons not traceable to the machine, and some users state that under such conditions the operator and helper have definite jobs to which they return until the machine is again needed.

In one case the operating expense is shown as $20.80, which may be due largely to charging idle time of the operator and helper against the machine, and is also due to a rather excessive moving charge made up of the time of a truck and trailer moving the ditcher from one job to another.

In spite of these few discrepancies in the matter of figuring costs, it happens that in two of the three cases, the job showing the largest charges per day also shows the largest average distance dug per day, so that the costs per foot of trench are not far out of line. In fact, the job which shows $12.65 per day operating expense shows the lowest cost per foot, namely, 3.8 ct. The costs vary from this figure to 8.1 ct. This is a job averaging only 3 ft. 8 in. deep, but the digging is described as very hard.

A tabulation of costs is reproduced. While most organizations are willing to discuss these matters of cost with individuals and companies, some are not willing to have their costs broadcast, so that names are omitted.

Trenching with Power Shovel

Methods used at New Bedford, Mass., that resulted in a large saving over hand labor methods were described as follows in *Water Works* by Stephen H. Taylor, Superintendent, Water Department, New Bedford, Mass:

The replacing of hand labor by machinery on the larger jobs is interesting as showing how much can be done by that method with a few men.

The New Bedford Water Works contemplated laying 6,600 ft. of 36 in. cast iron pipe, in addition to the ordinary annual extensions which are necessary to keep pace with new building operations constantly creeping out beyond the limits of existing mains.

Labor was very scarce; to say nothing of the excessively high wages demanded.

It was decided to purchase a 14B Bucyrus steam shovel with an extended dipper arm and a special trenching dipper of half yard capacity, which permits the digging of a trench with perpendicular sides and sufficient depth. We afterward used a ⅝-yd. dipper on the same machine with good results for the wider trenches.

The shovel travels over the trench on platforms made of 10x10 in. or 12x12 in. green oak timbers made up in sections. These sections are long enough to give a good bearing on the sides of the trench and about 6 or 7 ft. wide. Three or four sections are used and the shovel quickly picks up the section behind and places it ahead as the work progresses.

Work was started on a line of 48-in. cast iron pipe about 19,000 ft. long. This work was located 8 to 11 miles from the center of the city and the laborers had to be either boarded near the job or transported to and from the city each day.

In order to facilitate handling the pipe, which weighed 4 to 4½ tons each, a 14Z Bucyrus "Clamshell" and derrick, mounted on caterpillar traction, was purchased. With this outfit and gasoline driven air compressors for handling ledge and large boulders, and gasoline-driven pumps for handling water in wet trenches, the work was accomplished by a crew of from 15 to 20 men and two or three trucks with dump bodies.

The shovel traveled over the trench on platforms, as previously described, depositing the excavated material into trucks which dumped it into the back fill close by. The derrick closely followed the shovel, thus keeping the haul from the track to a minimum.

With the outfit described above and reasonably good earth conditions from 120 to 180 ft. of trenching, pipe laying and backfilling per day was accomplished. The crew was so small that transportation to and from the job daily was an easy matter.

Some sections of the work were in sand, too soft to carry the steam shovel over the trench. Under that condition the excavating was done by a clamshell bucket on the derrick, laying alongside the trench. The banks were so slippery that it sometimes required quick work to get a pipe in the trench before the bank slid in.

The work, with the exception of a little filling in of a low section which was completed early in the third season, was completed in two seasons, laying off during the winter months.

All sorts of earth conditions were encountered: hard pan, with large boulders, quicksand, dry, sliding sand and even swamp where pile driving was necessary. The same derrick with the 30-ft. boom made an excellent pile driver.

I can heartily recommend the above described outfit to anyone having a big job of pipe laying to do.

The cost of the two jobs described was as follows:

Cost of 48-In. Main Laid in 1921, 1922, 1923
Class "B," "C," "D," N.E.W.W.A.

Pipe—$46.50 per ton, 18,813 ft.
Specials—$130 per ton.

	Total	Per Ft.
Pipe and specials	$326,096.04	$17.33
Gates, hydrants and checks	13,055.06	.69
Leadite and gasket	6,364.32	.34
Tools*	29,173.31	1.56
Labor (see sub-division)	93,705.33	4.98
Lumber	4,551.11	.24
Fuel, oil and grease, etc.	7,205.01	.38
Consulting engineering	1,179.76	.06
Replacing road surface	8,929.56	.47
Miscellaneous expense: Traveling, telephone, telegraph, printing, accident, etc.	5,535.30	.29
	$495,574.80	$26.34

*Includes new tools purchased which are still in good condition to the value of $18,940.05, or about $1.00 per foot.

Labor may be divided as follows:

	Total	Per Ft.
Excavating, laying, backfilling, grading and watchman	$84,598.48	$4.50
Unloading and distributing pipe	6,906.52	.37
Tools	1,574.48	.08
Preliminary work	625.85	.03
	$93,705.33	$4.98

Cost of 36-In. Main Laid in 1920, 1921
Class "D," N.E.W.W.A.

Pipe—$64 per ton, 6,846 ft.
Special—$145 per ton.

	Total	Per Ft.
Pipe and specials	$121,191.85	$17.70
Hydrants and gates	6,052.25	.88
Leadite and gasket	1,441.85	.21
Labor	33,139.98	4.84
Fuel, oil, grease	330.34	.05
Lumber	502.90	.07
Miscellaneous	371.50	.06
	$163,030.76	$23.81

We have used the shovel for some of the smaller jobs in the city; but for short lines scattered in various sections of the city it does not pay, as the cost of moving long distances is excessive.

Another interesting feature of the laying of the 48-in. cast iron pipe was laying a curve of approximately 14° or 1,740-ft. radius with straight pipe. It was pronounced by all who saw it as a pretty piece of pipe laying, and was perfectly tight when the water was turned on. This curve was in swampy country and mostly laid above the surface

PERFORMANCE OF TRENCHING MACHINE—MACHINE VERSUS HAND METHODS

Trench Excavation—Nature of Soil	Width of Trench in In.	Depth of Trench in Ft.	Trench Dug, Ft.	Machine	Machine: Labor Cost	Machine: Man-Hours	Machine: Fuel Cost	Machine: Repair Cost	Machine: Freight or Drayage	Machine: Interest	Machine: Depreciation	Machine: Total Cost	Machine: Cost per Trench-Ft.	Hand Work: Man-Hours	Hand Work: Labor Cost	Hand Work: Tool Expense	Hand Work: Total Cost	Cost per Foot	Saving per Trench-Ft.	Total Saving
In parking—no lawn, hard dirt	18	3.5	9,110	383	$181.87	164	$58.30	$95.00	.....	$42.64	$85.28	$463.09	$0.05	4,354	$1,883.18	$139.42	$2,022.60	$0.22	$0.17	$1,159.51
In parking—no lawn, hard dirt	18	4	356	30	12.94	10	3.60	4.00	.....	2.60	5.20	28.34	.08	166	72.87	8.50	81.37	.23	.15	63.03
In parking—no lawn, hard dirt	18	5	325	16	8.00	8	2.40	3.50	.....	2.08	4.16	20.14	.06	223	97.56	6.80	104.36	.32	.26	81.22
In parking—no lawn, hard dirt	18	5.5	200	16	8.00	8	2.40	2.25	.....	2.08	4.16	18.69	.09	160	70.00	6.80	76.80	.30	.29	57.91
In parking—no lawn, hard dirt	18	3.2	1,553	84	42.18	40	18.14	18.00	.....	10.40	20.80	109.52	.07	835	365.55	34.00	399.55	.26	.19	290.05
In surfaced street, loam	18	3.5	2,451	92	41.55	41	13.75	17.00	.....	10.66	21.32	104.28	.04	992	428.88	30.20	459.08	.19	.14	354.80
In paved street, loam	18	3	104	3	1.40	1	.50	1.00	.....	.26	.52	3.68	.04	37	16.20	.85	17.05	.16	.13	13.37
Unsurfaced street, hard dirt	18	3.5	2,850	136	72.00	68	19.38	49.37	$29.55	17.34	34.68	222.32	.08	1,204	526.96	40.22	567.18	.20	.12	344.36
Unsurfaced street, hard dirt	18	4	424	16	8.00	8	2.08	7.35	1.59	2.04	4.08	25.14	.06	175	76.34	5.84	82.18	.19	.13	57.04
Surfaced street, hard dirt	18	3.5	1,229	104	52.00	52	14.38	21.29	11.66	13.26	26.52	139.11	.11	526	221.23	17.57	238.80	.19	.08	99.69
Surfaced street, hard dirt	18	4	233	24	12.00	12	2.40	4.04	2.24	3.06	6.12	29.86	.13	160	69.90	5.34	75.24	.32	.19	45.38
Surfaced street, hard dirt	18	5	100	12	6.00	6	1.12	1.73	1.11	1.53	3.06	14.55	.15	72	31.50	2.40	33.90	.34	.19	19.35
Surfaced street, hard dirt	18	3.5	4,261	232	113.50	116	47.69	87.00	32.00	59.71	119.42	459.32	.10	2,389	1,045.40	79.79	1,125.19	.27	.17	665.87
Paved street, hard dirt	18	3	195	16	8.00	6	2.40	3.37	1.35	1.53	3.06	19.71	.10	80	35.10	2.67	37.77	.19	.09	18.06
Surfaced street, rocky soil	18	3.5	693	44	22.00	22	5.76	.....	11.03	8.41	16.81	64.01	.09	512	207.90	17.10	225.00	.33	.24	160.98
Surfaced street, hard dirt	18	3.5	209	16	8.00	8	3.48	.....	4.01	3.06	6.11	24.66	.12	155	62.70	5.16	67.86	.32	.20	45.20
Unsurfaced street, rocky soil	18	3.5	700	38	19.00	19	6.89	.....	9.53	7.26	14.52	57.20	.08	516	209.85	17.23	227.08	.32	.24	169.80
Paved street, hard dirt	18	4	363	20	10.00	10	2.47	.....	5.01	3.82	7.64	28.94	.08	178	72.45	5.96	73.41	.22	.14	49.47
Paved street, hard dirt	18	3.5	424	22	11.00	11	8.70	.....	5.52	4.20	8.41	37.85	.09	313	127.20	10.44	137.64	.32	.23	99.81
In parking—no lawn, rocky soil	18	3.5	164	8	4.00	4	2.10	.....	2.01	1.53	3.06	12.70	.08	121	49.15	4.04	53.19	.32	.24	40.69
In parking—no lawn, rocky soil	18	4	397	20	10.50	10	4.09	.....	5.01	3.82	7.64	31.06	.08	171	69.40	5.69	75.09	.19	.11	44.03
In parking—no lawn, rocky soil	18	3.5	300	14	7.00	7	1.68	.....	3.51	2.67	5.35	20.21	.07	148	60.00	4.94	64.94	.22	.15	44.73
In parking—no lawn, hard dirt	18	4	231	12	6.00	9	1.52	.....	4.51	3.44	6.88	22.35	.09	100	46.20	3.35	49.55	.21	.12	27.20
In parking—no lawn, hard dirt	18	3.5	224	10	5.00	5	1.05	.....	2.51	1.91	3.82	14.29	.06	110	44.80	3.69	48.49	.22	.16	34.20
Surfaced street, hard dirt	18	3.5	1,110	80	54.00	40	15.90	15.90	5.59	17.79	35.57	144.75	.13	1,268	565.00	42.35	597.35	.54	.41	455.21
Surfaced street, hard dirt	18	4	6,639	415	234.00	208	74.38	69.10	29.04	92.48	184.77	683.97	.10	7,584	3,319.50	253.30	3,572.80	.54	.44	2,888.83
Surfaced street, hard dirt	18	4.5	202	16	9.00	8	2.30	2.65	1.12	3.56	7.11	25.74	.13	231	101.00	7.72	108.72	.54	.41	82.98
Totals			35,047	1,880	$966.94	901	$318.86	$402.55	$167.90	$323.14	$646.07	$2,825.05	$0.08	22,780	$9,865.82	$761.37	$10,627.19	$0.30	$0.22	$7,804.14

DITCHER COSTS FROM DETAILED REPORTS FROM OWNERS

Year Bought	Age When Costs Figured	Width in In.	Depth in Ft.	Type of Soil	Number of Working Days	Total Dug in Ft.	Speed of Digging	Total Investment	Overhead: % Depreciation	Overhead: % Interest	Overhead: % Repairs Including Teeth	Overhead: % Total Overhead	Operating Expense—Dollars per Day: Per Year	Per Working Day	Operator	Helper	Gas	Oil, Grease, Miscellaneous	Total	Total Daily Expense Over head and Operating	Average Dug per Day in Ft.	Cost in Ct. per Ft.
1924	2 months	9	4	Sand-clay soil, boulders in clay..	52	46,231*	36 in. a min.	$12,600*	9.9	3.2	0.14	13.24	$ 557.00§	10.70§	11.10*	8.67*	3.80*	0.71*	8.09‡‡	18.79	297	6.34
1925	1 year	9	4	Sand-clay soil, boulders in clay..	196	176,076*	36 in. a min.	12,600*	37.7	11.7	3.4	52.8	2,210.00	11.30	10.40*	8.71*	3.14*	1.66*	7.97‡‡	19.27	300	6.5
1924	1 year	18	3⅜	Loam, hard dirt, rocky soil	112½	35,047		4,866	13.3‖	6.7‖	8.3‖	28.3‖	1,371.76‖	12.20	8.60	§§	2.82	1.49	12.91	25.11	311	8.1
1926	2 months		4		54	18,570		5,600	7.7¶	2.17	0.04¶	9.91¶	555.50¶	10.30	2.17	1.34	1.64	2.02	7.16	17.46	344	5.08***
1925	2 years	18	5	Boulder clay with some sand loan; 50% hard digging	400†	100,000		5,450	24.0	3.5	13.75	41.25	2,250.00	11.25	5.00	.....	2.50	‖‖	7.50	18.75	250	7.5
1927	7 months	18	4	Boulder, clay and sand	178‡	110,415		5,500	20.0**	8.0	7.0	35.0	1,925.00	10.80	6.30	4.50	1.46	0.39	12.65	23.45	620	3.8
1927		18	5	10,000 ft. in hard pan	70	39,147		5,950	12.7††	3.8	6.0	22.5	1,341.00	19.16	7.70	3.21	1.72	8.17¶¶	20.80	39.96	559	7.2

*Total for three ditchers.
†Estimated.
‡1,603 hours.
§Each ditcher.
‖Ten months.
¶Two months.
**Barber-Greene figure, reported by owner as 3 per cent.
††One job.
‡‡One ditcher.
§§Included in expense for operator.
‖‖Included in expense for gas.
¶¶This includes large charge for
***In publication of the Iowa State College, Vol. XXVI, No. 34, page 17, reads 5.80 in error.

of the swamp. It was well braced to prevent the joints from blowing out.

Practically all the joints on both the 36-in. and 48-in. lines were made with leadite and braided jute packing, which resulted in a great saving of labor, especially in wet trenches, where the digging and maintaining of larger bell holes would have entailed much more labor and expense.

As an illustration of the difference in cost of joints made with lead and leadite; two lead joints were made at a cost for packing, lead and labor of $18.06 each, whereas the same items for leadite joints cost about $4.42 each. It took three men one hour and forty minutes to make a lead joint, whereas the same three men averaged from six to eight joints per hour with leadite. This does not take into account the extra cost for bell holes when lead joints are made.

Cost of Trenching by Hand

The following cost data on the construction of a small sewer, the trenching for which was done by hand, was given in *Municipal News and Water Works* by Samuel Vadner, Engineer, Wilmington, Del.:

The Oak Grove sewer starts from the septic tank of the Oak Grove School, Elsmere, Del., and runs 1,285 ft. to Chestnut Run, discharging in the open stream. It is wholly a sanitary sewer, handling the discharge from the septic tanks only, except for some rain water from the Oak Grove School at the upper end, which was included with the idea that this water would act as a flushing stream for the sewer. The upper 700 ft. of the sewer is 8-in. T. C. pipe and the lower 585 ft. is 10-in. T. C. pipe, all with cemented, wiped joints and laid to a uniform grade of 9 in. per 100 ft. There are 6 brick manholes.

General Features.—The job was awarded to the lowest bidder, who was 15 per cent under his next competitor. The low bid was due to insufficient previous experience of the contractor at this phase of contracting, as a result of which he did not figure the estimate accurately. All digging was done by hand, using colored labor working a 10-hour day at $0.40 per hour. Five weeks were required to complete the work. The average depth of the trench was 6½ ft. The subsoil was red clay with occasional stratas of water-bearing gravel. Only a slight amount of trouble was occasioned by water, and this was chiefly after two heavy rains. Approximately 800 cu. yd. of dirt were excavated, including that for manholes.

An 18-ft. concrete base road was dug through, as was a double line of street car tracks. Except for 200 ft. of the line along the edge of a field, the balance of the distance was along two cinder topped dirt roads. Due to the solid nature of the ground it was unnecessary to sheet any of the trench. The average width of trench was 30 in., although specifications would allow a minimum of 6 in. on either side of a pipe bell which would result in a minimum width trench at the bottom of 24 in. for 8-in. pipe and 26 in. for 10-in. pipe.

Explanation of Cost Items.—The contractor lost $398.96 on this job, or 15 per cent of the total contract price of $2,644. The loss did not include some small further overhead loss such as interest on money, office expense, etc. However, of the labor charged under the heading of "foreman" $72 was done by a brother of the contractor, who drew no pay, but worked only for a share of possible profits. Of "equipment hire" only the items of $15 for use of the air compressor and drill, and $5 for centrifugal pump hire, were paid out in full, as the remaining equipment belonged to the contractor and would probably have stood idle if not used on this job. For the purpose of job cost accounting the equipment is charged against the job at current renting rates for the same or similar equipment. Of the remaining $252 charged as "equipment hire" probably $60 represented a profit to the contractor using his equipment on this job rather than have it idle. This $60 contingent credit plus the $72 labor credit would reduce the contractor's loss to $267, or 10 per cent. As there were 15 houses along the line of the new sewer, the contractor expected to get a number of profitable small jobs without much competition installing septic tanks for these houses and connecting them to the new sewer. Only one house owner had this done while the main sewer was being put in and the profit from this source was negligible.

The job included at the lower end a 60-ft. concrete retaining wall containing 17 yd. of 1:3:5 concrete.

The cost of the work was divided as follows: Labor 69.2 per cent, material 21.0 per cent, equipment hire 8.8 per cent, insurance 1 per cent. From observation five-eighths of the laborer's cost of $1,172, or $1,070, was for excavating, some dirt being handled twice, due to the depth of trench.

Conclusions.—The labor cost precluded the contractor from any chance for profit. There was a trench digging machine within a few miles which could have been hired to dig all the trench, except the street and car track crossing. The only pipes encountered were two 1-in. gas pipes. A trench machine could have cut 1,200 ft. in 10 working days at a rental of $40 per day, including fuel and operator. This expenditure of $400 would have reduced the $1,070 estimated excavating cost to $670, allowing $270 for cleaning up the trench after the machine and excavating the car track and road crossing. A further saving of $12 on insurance and $77 in foreman's wages by shortening the time from five to three weeks would have been effected. This total saving of $499 would have turned the $398.86 loss into a profit of $100.04, or 3.2 per cent.

Cost Data.—The cost of the work was as follows:

Labor:		
Laborers, 278 men-days, at $4 (10-hour day)	$1,712.00	
Night watchman, 4 nights, at $4	16.00	
Foreman, 34, at $7 a day	238.00	
Bricklayer (union), 7¾x8 hours, at $1.62½	102.00	
Formsetters, 7x9 hours, at $1	63.00	
Total labor		$2,131.00
Equipment Hire:		
Trucks (1½-ton), 18x10 hours, at $1.25	$ 225.00	
Tractor grader, 4 hours, at $2	8.00	
Air compressor and paving breaker, 3 hours, at $5	15.00	
Concrete mixer, 1 bag, 1½ days, at $6	9.00	
2½-in. diaphragm hand pump	10.00	
2-in. centrifugal pump, 5 days, at $1 per day rental	5.00	
Total equipment hire	$ 272.00	
Material:		
174 sacks cement, at $3 a bbl. del. (in paper)	$ 130.50	
6 sacks Lumnite cement, at $2 for 3-in. street crossing base	12.00	
6,000 common bricks, at $25 per M	150.00	
6 manhole frames and covers, at $26 (Lobdell Foundry, Wilmington)	154.00	
11 yd.—15 tons concrete sand, at $1.40 ton, not including hauling by contractor's truck	22.40	
7 yd.—10 tons plaster's sand, at $1.50 ton, not including hauling by contractor's truck	15.00	
6 yd. cinders, at $0.50 (not including hauling done by trucks charged under labor)	3.00	
1 ton Amiesite, 10 yd. sq. 2 in. thick in place, at $1.70	17.00	
Gasoline and oil for pumps	2.40	
Form lumber, 1x6 and 2x4, 1,800 B. M. at $36	54.00	
24 yd. gravel (1-in.), at $1.75 per ton, 2,600 lb.—1 yd. (20 yd. for wall, 2 yd. for street crossing base, 2 yd. M. H. bottoms)	54.60	
8½ yd. used paving brick and brickbats (hauling charged under labor)	N. C.	
2 two-ton truckloads of old lumber, including 3x12-in. used in 6-ft. lengths for placing every 25 ft. across trench and nailing stakes to	N. C.	
6 individual "tin" pipe forms for manhole inverts in place	18.00	
Total material	$ 647.90	
Summary:		
Contract cost of job		$2,590.00
Extras, manhole $75, 10-in. pipe instead of 8-in.—100 ft. and 5 extra wyes at $0.63 (all fittings cost double price of pipe)		93.90
Equipment hire	272.00	
Labor	2,131.00	
Material	647.90	
Insurance—workmen's compensation, 1½ per cent payroll	31.96	
Loss		398.96
Total	$3,082.86	$3,082.86

The Construction of the Distribution System

Useful information based on the methods and practices at Council Bluffs, Ia., was given in *Municipal News and Water Works* by C. L. Ehrhart, Superintendent Water Works, Council Bluffs, Ia.

It will be assumed that the design of the proposed project is according to good practice and that the materials have been ordered. Therefore the first operation that confronts us is the handling of the pipe from the car.

Handling the Pipe.—Under no circumstances should pipe be allowed to drop or swing against anything that will cause it to crack. It should be handled by means of skids, or better yet, by derricks or cranes which can swing it clear of all obstacles and deposit it without undue jar wherever required. For use in handling small pipe, the writer has found the best method to be by means of a derrick having a 10-ft. boom and mounted on a heavy truck. This derrick is of a type generally advertised, and is inexpensive to buy and can be used for handling many other things than pipe. Such a derrick can even be mounted on the side of a freight car, if it is not convenient to mount it on a truck, and then taken down after the car is unloaded. As soon as the pipe is lifted from the pile, it should be sounded for defects, then swung around and lowered. It is not always possible to lower the pipe directly to stock piles, but several lengths can be laid crosswise on the truck back of the derrick and taken over to the stock pile and put in place quickly. Probably the handiest and neatest stock pile is one in which the pile alternates in the placing of the bell and spigot ends with each layer turned 90 degrees in direction. Such a pile is not liable to slip causing breakage or accident and is handier to check. Many times the pile can be loaded directly to the trucks or trailers and taken to the point where it is to be laid. In the case of large pipe it is often economical to have some company equipped with large stationary booms do the handling. In Council Bluffs we are fortunate in having a bridge company which will unload large pipe to our trucks and trailers at $5.00 per car.

Delivering Pipe to Job.—We have found it most economical to deliver pipe to the job by a truck pulling a trailer where possible. Trailers are rather inexpensive affairs, and we believe no water department should be without one or more. We have been able to haul from 4 to 5 tons on a single trailer in addition to the pipe on the truck. In removing pipe from the truck or trailer to the ground, care should be taken that there is no chance of breakage. On dirt streets it is possible to slide the pipe off the end without damage, but on paved streets such a practice cannot be carried out. We have found it best to lower pipe on paved streets with the above mentioned derrick mounted on a truck. As this truck is also used in lowering the pipe into the trench, it is not necessary to string the pipe with the bell ends one way, for it is a small matter to swing a pipe around when suspended from the boom. We have also had occasions when it was not advisable to string the pipe at all, but to pile it on the parking at convenient locations. In this way it can be stored longer without complaint from the public and without the danger encountered by stringing the pipe in the street. As the pipe has to be picked up by the truck for placing in the trench, the short run necessary to take it from the pile to the trench does not noticeably hold up the work as would be the case of handling by hand.

Digging the Trench.—With the material on the ground, the next operation is making the excavation. Some of the larger cities are fortunate enough to have trenching machines, but in the smaller or medium sized cities, we believe most of this work is done by hand. In either case the trench should be dug wide enough to allow the back filling material to slip past the pipe and fill the lower quarters below the pipe. If a ditch is cramped for width, the back filling material is likely to rest upon the top of the pipe, causing an undue strain and possible breakage. If the trench is wide enough to allow proper back filling, it is also wide enough to work in comfortably. In the northern part of the United States the depth of the trench is generally regulated by the frost line, the cover being sufficient to insure against freezing. This cover is generally enough to properly cushion the pipe against excessive weight and the consequent strain.

Proper tools should be provided for the excavation work. In cases where it is necessary to go through paving or hard dirt surface, we have found that the cut can best be made with busters or spades operated by compressed air. The compressor is one of the handiest tools the water works man can have, as it takes care of a great many hard jobs which are expensive to handle by hand. While it is better to have a compressor of at least 100 cu. ft. capacity, smaller ones may be purchased and mounted on a truck and driven from the drive shaft. The larger compressors should be purchased mounted, or mounted on the running gear of a second-hand truck and used as a trailer. To avoid undue jar to the compressor, the running gear should have good springs and at least solid tires if pneumatics are not available. All the tools in excavation work should be kept in good condition, and the spades and shovels should be of a light high-grade steel. The best shovels and spades are the cheapest in the long run and are not so tiring to the workmen due to their lightness.

The Trench.—The trench which is to receive the pipe should be graded with a string line the same as for sewer work, making the high and low points come at hydrant locations, if possible. This will insure that the sediment can be blown out at the low points and the air taken out at the high points, preventing the line from becoming air bound. If the walls of the trench being dug are dry and of the right material, no bracing will be necessary. However, sandy or wet material will require bracing in order to make the trench safe and allow the placing of the pipe. Water in the trench should be removed before attempting to place any pipe. Formerly this was taken care of by hand trench pumps, but the gasoline driven units are now so inexpensive that no pipe laying crew is complete without them. Clear water may be removed by motor driven centrifugals to good advantage. In laying out trenches it is a good plan to keep at least 5 ft. away from other parallel trenches, if possible, so avoiding the chance of the ditch on the side near the parallel trench caving in. Such cave-ins generally come without warning and are apt to be serious. Formerly when it was necessary to roll the pipe into the ditch, it was customary to pile all the dirt on one side of the trench. This sometimes created cave-ins because of the excessive weight of the dirt. Where the pipe is handled by derricks or cranes, it is not necessary to keep one side of the trench clear, but it is better to divide the dirt and thus spread the weight on both sides of the ditch. In the past it has generally been customary to dig the bell holes as the pipe was placed in the trench. However, where portable trucks are used it is possible to lay from 10 to 12 lengths per hour, so the bell holes cannot be dug after the pipe is in the ditch without delaying the work. Under such conditions it is better to measure off the bell hole locations and put enough men digging bell holes so as to insure no delay in the pipe laying.

Laying the Pipe.—With the trench ready to receive the pipe, it is important that the laying proceed as fast as possible. With the portable truck derrick the pipe should be raised with the sling around the middle so as to keep it balanced. As soon as it is clear of the ground, the pipe should be given a final sounding to prevent defective or cracked pipe from entering the ditch. The derrick is then run alongside the ditch, the boom swung around and the pipe lowered. In the meantime one man should clean and dry the bell of the last pipe laid very thoroughly, as many defective joints are caused by dirt or foreign matter. When the next pipe is lowered the same man should also clean the spigot end. He should then place a strand of hemp around the pipe and guide it into place when it is sent home. The best hemp to our notion is of the dry braided type, and two strands are usually sufficient. Should the pipe pinch to one side as it is being entered, it is easy to swing it from side to side or raise it with the derrick until the hemp is driven home and spigot end properly centered in the bell.

In cases where it is impossible to use a derrick, the pipe may be lowered into the trench by means of a rope at each end with a rolling hitch, one end of each rope being held under the feet of the men lowering, and the other end paid out as evenly as possible so as to lower the pipe without dropping. In this way two men can lower a length of pipe. For sizes too heavy for lowering by hand, a four legged derrick can be used, or even better, a large crane or drag line.

Making the Joints.—After the spigot end of the pipe is home and yarned, the joint should be prepared immediately for the joint material, as delay may cause foreign matter to enter. We believe it is best to use a square running rope with a clamp to tighten it up. We have also found it best to seal this running rope against leakage by the use of fire clay rather than ordinary clay. Fire clay may be used over and over again and is not expensive in the long run. After the running rope is sealed, a gate should be built up depending upon the materials used for joint purposes. Either lead or lead substitutes require heating, and while formerly the kettles were heated with a wood or coal fire, it is much better to use a kerosene burner, as it will heat the material quickly and once heated will hold it in readiness for use, insuring against delays caused by cold material. The joint material should be handled carefully so as to avoid spilling and the possible injury to workmen. The pouring of the joint should be done continuously, and in case that one pot will not run the joint, additional pots should be in readiness to carry the pouring out with the least break in time. Immediately after the pouring of the lead, it should be caulked to take up the shrinkage caused by cooling. Formerly most of this work was done by hand, the caulker running around the pipe first with a chisel following up with the caulking irons, using the small ones first. However, if compressed air is available, this method should be used in caulking. Compressed air driven joints are better than hand driven, as the lead can be taken up from an eighth to a quarter-inch more than by the hand method without any danger of splitting the bells. Such joints are superior, as the last one driven during the day is as good as the first, whereas the quality of hand caulked joints is liable to lag during the latter part of the day. Furthermore, where the pipe is being laid in large quantities it is absolutely necessary to caulk by air in order to keep up with the laying crew. Sometimes on the larger joints the lead fails to pour evenly, causing a break in the joint, but this may be remedied by caulking lead wool into the spot where the break occurs.

Pouring Wet Joints.—At times unavoidable conditions cause the joints to become wet, and extreme care must be taken in pouring such joints. Before pouring the lead a quantity of coal oil should be poured into the joint, followed immediately by the lead. In place of the coal oil, lubricating oil or candle shavings may be used with equally good results. It is also a good plan to make a small hole with a knife in the bottom of the joint for drainage purposes. This may allow a little lead to run through, but it will soon freeze at the point of drainage and pour properly. When the pipe is finally placed in the ditch, it should not rest on any solid or unyielding projections, but should lay evenly so that it will not be subject to any strain, as every strain is a potential trouble maker.

Cutting Pipe.—The writer has seen many cases of poor pipe cutting caused by awkward methods. A pipe can be cut fairly even if the work is done right. Before attempting to make a cut the pipe should be marked at the exact distance from the end by means of a tape or rule. It is then possible to place a running rope or even cloth tape around the pipe at this point, after which the whole circumference of the pipe may be marked very easily. A cross mark should be made to show the starting and ending points of each turn of the pipe. The pipe should then be placed on a heavy timber with the cutting line directly over the middle of this timber. Starting at the cross mark a slight cut should be made using a sledge and hardy. When the cross mark is reached the pipe should be rolled back to the point of beginning, after which a second and heavier line may be cut with the hardy. By rolling the pipe back and starting the cross mark each time, the strain will be kept equal. Finally the pipe will become crystallized to the point where it will snap off fairly evenly without projections exceeding a quarter of an inch. In making cuts on larger pipe it is a good idea to make the first round with a diamond point, as this removes a considerable amount of the material. Then by following with the hardy, as above mentioned, pipe will crystallize and crack. Cutting old pipe in the ditch has been more or less difficult, particularly in the large sizes. When the cut was made with regular cutters, the pipe was generally bound in place even after the cut at both ends was complete, making it necessary to break the pipe, which was oftentimes hard to do in the larger sizes. There is on the market at the present time an oxy-acetylene outfit having a special torch for burning castiron pipe, and we have found this to be the handiest method of cutting pipe in the ditch, as the cut is at least a quarter of an inch wide, and the pipe is free as soon as the cuts are made. To secure the best results with such an outfit, the pipe should be drained, as water in the pipe tends to carry away the heat. It is also best to make the first round with the diamond point, as any chalk marks are burnt off by the hot flame, while the track made by the diamond point can be readily seen.

Valves.—Every distribution line should be properly valved. most of us have had occasions when we would have given much to have had valves at the proper locations. These valves should be spaced so that a minimum amount of main is thrown out of service whenever it is necessary to work on the line. Not only is this according to the Underwriters' specifications, but it prevents the needless shutting off of house service. If the Underwriters' rules are followed, the system will always be properly valved. In setting valves a concrete base should be provided so that there is no chance of the valves settling. We have found concrete from old sidewalks to be ideal for this purpose. Every valve must necessarily be provided with a valve box or manhole so that shutoffs may be made quickly. The question of whether to use boxes or manholes is more or less optional in the small sizes, but valves larger than 12 in. should always have the manholes.

Hydrants.—Hydrants should be set at least not farther apart than each street intersection, and in the business district, or in the residence district where the intersecting streets are too far apart, additional hydrants should be set in the middle of the block. At least the business district should be equipped with steamer hydrants, and it is better if the residential districts can also be equipped with the same although the necessity is not so great. In placing hydrants care should be taken that the hydrant is kept far enough back of the curb to clear all automobile bumpers, and it should be set high enough so that the fire department will experience no difficulty in making the hook-up by reason of dirt or snow being too close to the caps. The writer has seen many hydrants set at crazy angles and has made it a point that all hydrants set under his direction were properly plumbed. After plumbing the hydrant should be braced near the top with temporary wood braces to hold it plumb while the back filling material is being tamped in place. The hydrant should have a base of concrete similar to that used for valves, and it is most necessary that the space back of the hydrant to solid ground be filled with concrete to prevent the hydrant from blowing off. No wood should be allowed in these braces, as it will rot and allow the hydrant to push away. At least a bushel or more of brickbats, preferably of soft brick, should be placed around the base of the hydrant to take care of the drainage water. If it is not provided, the hydrant will not drain, with the probability of freezing. The writer has never set a hydrant without an auxiliary valve in front of it. The expense is not great and is justified, as it allows the hydrant to be repaired without interference to service. Hydrant connections should be not less than 6 in. in diameter and the hydrant should preferably be of the same size.

Connecting New Lines.—Connecting new lines at right angles to old lines not provided with tees or crosses, naturally necessitates a tap which may be made in two ways, by means of a machine, or by cutting out a section of the pipe and setting in a tee or cross. When made by machine care should be taken that the split sleeve is centered evenly around the pipe and that there are no defects in the joint. The sleeve should be carefully leveled before the joint is run. After the tee is in place and the joint caulked, the machine should be hooked up and the cutting started. The pilot cut is easily made, but the main cut takes considerable labor, and it is of importance that the cutters be sharp and all ground to an even length, otherwise the cutting will be uneven and exceedingly hard to make. After the cut is made and the piece drawn out, the valve should be closed and the machine removed, after which the laying of the pipe may proceed in the ordinary manner. In cases where it is necessary to insert a tee or cross, a section of the pipe should be taken out, after which the fitting may be set in place and the opening closed by means of a short length of pipe and a sleeve. Where the sleeve is placed a small section of the pipe is generally missing due to the fact that it had to be cut short in order to enter the bell. Should a valve be placed close to this point and the pressure applied to one side of the valve only, there is a possibility of the valve pushing toward this open space and opening up a joint at the valve. This space may be elimi-

nated by cutting a very short section of pipe and dropping it in the opening before the sleeve is set.

Fittings such as tees, elbows and plugs must be properly braced against solid earth in a manner similar to the bracing required for a hydrant. If such bracing is not placed, the chances are that the pressure will open up a joint or crack a pipe near the fitting. Sometimes it is necessary to brace back a considerable distance, and we have found it very convenient to use old pipe between the fitting and solid earth in such cases.

Testing the Pipe Line.—At the completion of each block of pipe, a test should be applied to prove that no defective pipe or joints are in the line. Formerly when central station pressure was carried for fire service, it was necessary to make what you might term a high service test, but since the advent of the fire department pumper, the policy of putting on additional pressure has practically disappeared, so that we feel safe in using domestic pressure for our tests. If possible test plugs should be provided so as to make it convenient for removing the air in the line and also for removing the plug when the test is completed. However, if test plugs are not available, an ordinary plug may be used with a lead joint shallower than normal. In cases where oxy-acetylene outfits are available, these joints may be melted very easily.

Back Filling.—Back filling may be done by machine, by hand back filler and team, or by hand, and the relative cost and speed is in the above order. Naturally a machine back filler is preferable, although the use of a hand filler and team does not cost so very much more. Hand back filling is expensive and should not be practiced, if possible. We have found it best to pile all the dirt over the ditch, and after it is filled to flush the ditch. If this flushing is done from above, the results will be poor and incomplete, as the dirt will wedge part way down in the trench, and the bottom of the ditch will not be properly settled. The best method of flushing is to place an 8-ft. pipe on the end of the hose and push this pipe into the ditch until it hits the water main. Then allow the water to flow until it shows up at the top of the ditch, after which the pipe may be moved forward about ten feet. This method is more efficient and better than hand tamping. We have taken a hand tamped ditch and applied the flushing in this manner and caused the dirt to settle several inches. Practically all the dirt that has been thrown out, except that displaced by the pipe, can be replaced in this manner.

Checking Costs.—The cost of laying a water main should be checked from day to day in order that everybody concerned is fully conversant with the results. The foreman on the job can practically make or break as regards costs. If he is in sympathy with the idea of economy and efficiency, and uses his head in planning his work and arranging his men, he can get good results at moderate costs.

Records.—With the job complete, a record should be made showing the length, depth, location of specials, hydrants, valves and any other data that might be of value in the future. This record should be placed on a map and filed away in a fireproof vault or safe. Card indexes should be made in duplicate showing location of all valves and hydrants, one set being kept in a fireproof place, and the other set kept convenient for instant inspection. Unless this is done, the project cannot be called complete.

Charging Water Works Construction Equipment

The following notes from *Water Works* show the practice of the Water Department of three cities in handling charges for their construction equipment:

New Bedford Charges Equipment to the Job.—We have two trenchers, a steam shovel, air compressors and a steam derrick. Any minor repairs that take place through the ordinary running are usually charged to the particular job on which the machine is working. For example, we bought this machine for an extension in laying a 40-in. pipe, and repairs were charged to that job. It has been working recently in some ditching work in connection with draining some of the swampy territory around the ponds. While that work is going on it is charged to that job, that is the ordinary small repairs. On any serious repairs, these equipments would be charged to account of tools, which account is included in our mains extension account.

We have no back fillers and air compressors are charged on our tools account, because that is going from one short job to another. Our trenching machines, of course, are not used on short jobs. The repairs are usually charged to jobs on which they are working, when it is finished up or broken down.—Stephen H. Taylor, New Bedford, Mass.

Plan at Youngstown, O.—We have a plan for handling this particular item which I feel is rather complete, in so far as we have a department called "auxiliaries." Auxiliary equipment is one branch of that department or system of accounting. In our auxiliary department expenses we have such operations as machinery, like the shop, garage or automotive equipment and a division under the care and supervision of a general, all-around mechanic, who is manager. This division is called construction equipment. In that department we have our two trenchers, air compressor, back fillers, tractors, trailers, our special pipe handling truck and our truck crane.

We considered for some time where to allocate the cost of maintenance and upkeep and how to distribute it equally among our various departments, which are main construction, maintenance and service construction.

Those three branches use our machinery. We have in addition a building construction division. We do all of our own contracting. Our expense, or rather the life of our machines, is estimated. We try to establish a rate based on the average life of such equipment.

We have an hourly rate for all of our machines, which this auxiliary department calls construction equipment and which we charge into main construction, service or maintenance. We are taking our compressor out on the road and charging $1.50 an hour to that job, which money is actually transferred on the books into our auxiliary equipment department. The $1.50 an hour price must absolutely support that machine. This department keeps its own costs. It has a system of cost and repairs in the operation of this machinery. This money goes back to the department and is placed to the credit of that machine at the end of five years, if it is correct to estimate the life of an air compressor at five years, a trenching machine at five, and a back filler at three. We attempt at the end of those periods to have money enough in those funds to replace the equipment. In that way we have continuously kept up an assortment of equipment, our additions to equipment being out of a surplus which we accumulate.

To determine this rate is quite a problem. We have been doing it now for three years and we found we made too little charge in our estimate. On the other hand, we felt that we should get $2.50 an hour from one of our departments for the operation of our trenching machine, and later found that that was too much. Because of the amount of available time and the low cost of that particular unit over the first two years, we were going to have in our treasury, by the end of a five-year period, enough money to buy three or four more machines.

We revised our rates downward. Every quarter we check up to get the rate per hour. We feel that at the end of those machines' useful lives we will have enough money in the fund to make replacements as well as keep those machines in wonderful condition. The expense of operating them is never charged to any one job. All departments pay the same for equipment and operation. Each department superintendent has to get his order in for construction equipment in his turn so that he will have a machine when he wants it.

We do all of our own construction work, all of our service installation, every bit of our building and small construction jobs, even to the repaving of streets. We have only one timekeeper, an accountant, and he has no trouble at all handling this detail of cost accounting. It really comes from the source on our daily time reports, which are turned in by the head of the department for these men. There is absolutely no excessive overhead or costs in keeping this system. It is convenient and has paid well for its time and trouble.

The problem of picks, shovels and other small tools is rather difficult. We have felt that to equip tool boxes with the ordinary amount of tools for the job, making replacements by charging it to the job itself is a pretty good plan. If the tool is lost on a job, certainly the cost of that replacement, say of a shovel, pick, lantern or whatever it is, should be charged to that particular job. Those things do not all wear out at once, they are being continually replaced so that we can charge such equipment into miscellaneous cost of doing a certain job. Our storekeeper has a job in that. A man cannot requisition a dozen new picks and shovels and get away with it in our department. If he tries such a thing there is some question and we refer his requisition back to his supervisor. That supervisor certainly has more tools laid away in the tool room somewhere which are charged to his department.

We do not let a tool out on a job without a requisition. If a man wants as many as five lanterns he can requisition them from the storeroom. If he wants two dozen it is up to his supervisor or he may provide those from other jobs. We aim at all times to avoid a surplus of tools from the division. Just as many as they need and no more. Of course, they have some from the blacksmith's shop, but we try to charge that to replacement of lost and worn-out tools, not to the job.—M. C. Kinder, Youngstown, O.

How Charges are Handled at Cleveland, O.—We charge a good deal to capital account. We have a great number of trucks and passenger cars. We carry the operation of these machines, trucks and so forth on the books against the maintenance and operation account. The operation is separate from the maintenance, and on our large construction jobs, a certain rate, depending on the size of the truck, is charged against that particular job as rental. On the smaller jobs in that connection we charge it to the consumer. We have smaller trucks with a rental charge per hour against that particular job, so that the rental charge we get on all the trucks will very nearly offset the maintenance and operation of these trucks. On the passenger cars, of course, we do not attempt to allocate any of the expense to the job itself, as supervision is charged as a maintenance or operation item of automobiles. We have a certain amount each year, based on our previous expense, as to what our budget must cover the following year, so we get into the job on trucking a fair charge for the use of machines.

The man in charge of the trucking division does no work with any trucks unless he gets a requisition from the department wishing to use that truck. Of course, if there is a pick-up job or a half dozen pick-up jobs, about all one can do is charge an estimated amount, including the time going to the station, picking up things from two or three different plants, and allocate that time and charge on the requisition. But that does not apply as much to the construction end as to the operation of small pick-up jobs.

All of our machines are classified. There has been a division started to take care of and find the actual cost for operation and maintenance of each machine. Numbers are put on each truck and on the passenger cars, instead of putting on speedometers, and a daily record of the gas and oil and everything that goes into the particular truck or passenger car is kept, so that within probably a year's time we shall have valuable data as to what the operation and maintenance of those cars are.—Mr. King, Cleveland, O.

Frost Penetration in City Streets

From an Article in Water Works, July, 1926, by Scotland G. Highland, General Manager, Clarksburg Water Board, Clarksburg, W. Va.

Frost Penetration and Depth to Which Mains and Services Are Laid in City Streets

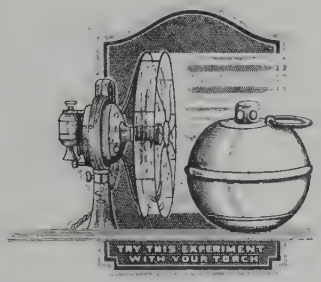
Name of State or Province and City	Lowest Depth of Frost Penetration in City Streets During the 25 Years, Ending March, 1926	Dept to Which Mains and Services Are Laid in City Streets (1926)
Alberta, Can.		
Calgary	12 ft.	8 ft. in loam, 10 ft. in gravel.
Edmonton	6½ ft.	8½ ft. trench for mains; 7 ft. trench for services.
Saskatchewan, Can.		
Moose Jaw	9 ft.	9 ft. cover.
Regina	.....	7½ ft. cover.
Ontario, Can.		
Brantford	.....	5½ ft. cover.
Chatham	3 ft.	4 ft. cover.
Ottawa	6 ft.	6½ ft. cover.
Windsor	.....	5 ft. cover.
Quebec, Can.		
Montreal	5 ft.	6 ft. trench.
Manitoba, Can.		
Winnipeg	7 ft.	7½ ft. cover.
Little Rock, Ark.	.....	2½ ft. trench.
Sacramento, Cal.	.....	2 ft. cover.
Colorado.		
Leadville	9 ft.	7 ft. cover.
Denver	.....	4½ ft. cover.
Colorado Springs	.....	4½ ft. cover.
Connecticut.		
Hartford	6 ft.	4 ft. cover.
Meridian	.....	4 ft. cover.
Wilmington, Del.	.....	3 ft. 8 in. cover.
Tallahassee, Fla.	.....	3 ft. trench.
Atlanta, Ga.	.....	Mains 2½ ft. cover; services 2 ft. cover.
Boise, Idaho	.....	4 ft. cover.
Illinois.		
Danville	4 ft.	5 ft. trench.
Quincy	3 ft.	Mains, 4½ ft. cover; services 3½ ft. cover.
Chicago	.....	5½ ft. cover.
Bloomington	.....	3½ ft. to 5 ft. trench.
Indiana.		
Richmond	5 ft.	Mains 5 ft. cover; services 4½ ft. cover.
Logansport	6 ft.	Mains 5 ft. cover; services 3½ ft. cover.
Gary	5 ft.	5⅜ ft. cover.
Terre Haute	5 ft. 7 in.	4½ ft. cover.
Fort Wayne	.....	5½ ft. trench.
Elkhart	.....	5 ft. cover.
Lafayette	.....	4½ ft. cover.
Iowa.		
Fort Dodge	7 ft.	5½ ft. cover.
Dubuque	6 ft.	6 ft. cover.
Des Moines	5½ ft.	6 ft. trench.
Council Bluffs	5 ft.	5 ft. cover.
Burlington	5 ft.	5 ft. cover.
Davenport	.....	6 ft. cover.
Cedar Rapids	.....	5½ ft. cover.
Kansas City, Kans.	.....	4 ft. cover.
Kentucky		
Louisville	.....	3 to 3½ ft. cover.
Frankfort	.....	3 ft. cover.
Baton Rouge, La.	.....	2½ ft. cover.
Maine.		
Portland	5 ft.	5 ft. cover.
Biddleford	.....	5½ ft. cover.
Augusta	.....	5 to 5½ ft. cover
Maryland		
Haggerstown	2 ft. 8 in.	3 ft. cover.
Baltimore	.....	Mains 3½ ft. to 4 ft. cover; services 3½ ft. cover.
Massachusetts.		
North Attleboro	7 ft.	6 ft. cover.
Fitchburg	7 ft.	6 to 7 ft. trench.
Springfield	5 ft. 10 in.	6 ft. cover.
Melrose	.....	5 to 5½ ft. cover.
Haverhill	.....	5 ft. cover.
Lynn	.....	5 ft. cover.
Brocton	.....	5 ft. cover.
Fall River	.....	5 ft. cover.
Beverly	.....	Mains 4½ ft.; services 5 ft., 4½ ft. cover.
Holyoke	.....	4½ ft. cover.
Gloucester	.....	4 to 5 ft. cover.
Lowell	.....	Mains 5 ft. cover; services 5½ ft. cover.
Michigan.		
Battle Creek	6 ft.	5 ft. cover.
Flint	5 ft.	Mains 5 to 6 ft. cover; services 5 ft. cover.
Detroit	5½ ft.	8 ft. trench.
Minnesota.		
St. Paul	11 ft.	Mains 6½ to 7½ ft. cover; services 7½ ft. cover.
Duluth	9 ft.	Mains 8 ft. to Axis of pipe; services 9 ft. cover.
Minneapolis	.....	2 ft. cover.
Jackson Miss.	6 ins.	4 ft. cover.
Kansas City, Mo.	2½ ft.	Mains 3½ ft. to 12 ft.; services 5 ft.
Montana.		
Great Falls	.....	6½ ft. cover.
Butte	.....	5½ ft. cover.
Helena	.....	5½ ft. cover.
Omaha, Nebraska	.....	4½ ft. cover.
New Jersey		
Patterson	3½ ft.	4½ ft. cover.
Jersey City	.....	4 ft. cover.
Trenton	.....	3½ ft. cover.
Elizabeth	.....	3½ ft. cover.
Camden	.....	3 ft. cover.
Sante Fe, N. M.	3 ft.	5 ft. cover.
New York.		
Buffalo	6 ft.	5½ ft. trench.
Elmira	4½ ft.	4½ ft. cover.
Syracuse	4 ft.	4 ft. cover.
New York City	2½ ft.	Mains 6 ft. trench; services 5½ ft. trench.
Ogdensburg	.....	5 ft. cover.
Albany	.....	5 to 6 ft. cover.
Glen Falls	.....	4½ to 6 ft. cover.
Gloversville	.....	4½ ft. cover.
Rochester	.....	Mains 2½ ft. trench; services 2 ft. trench.
Raleigh, N. C.	1 ft. 3 in.	7 ft. cover.
Bismark, N. D.	.....	5 ft. cover.
Ohio.		
Akron	6 ft.	4 ft. cover.
Toledo	4½ ft.	3½ ft. cover.
Cincinnati	3 ft.	6 ft. cover.
Cleveland	.....	Mains 4 ft. cover; services 3½ ft. cover.
Lima	.....	3½ ft. cover.
Columbus	.....	Mains 5½ ft. cover; services 5 ft. cover.
Pennsylvania.		
Hazelton	7½ ft.	6 ft. cover.
Erie	.....	Mains 4½ ft. cover; services 3½ ft. cover.
Altoona	.....	4 ft. cover.
Pittsburgh	.....	4 ft. cover.
Allentown	.....	3½ ft. cover.
Chester	.....	3 ft. cover.
Harrisburg	.....	3 ft. cover.
Johnstown	.....	3 ft cover.
York	.....	6 ft. cover.
Rhode Island.		
Woonsocket	7 ft.	6 ft. cover.
Providence	.....	Mains 4 ft. 8 in. to center of pipe; services 4 ft. 6 in.
Salt Lake City, Utah	3 ft.	4 ft. cover.
Montpelier, Vt.	.....	5½ ft. cover.
Richmond, Va.	.....	Mains 4 ft. cover; services 2½ ft. cover.
Washington.		
Spokane	5½ ft.	4½ ft. cover.
Everett	1½ ft.	2½ ft. cover.
Seattle	.....	Mains 4 ft.; services 2 ft.
West Virginia.		
Wellsburg	.....	4½ ft. cover.
Wheeling	3 ft.	3 ft. cover.
Clarksburg	3 ft.	4 ft. cover.
Bluefield	2½ ft.	4 ft. cover for mains; services 2½ ft. cover.
Parkersburg	.....	3 to 6 ft. cover.
Charleston	.....	3 ft. cover.
New Martinsville	.....	3 ft. cover.
Wisconsin.		
Madison	6½ ft.	6 ft. cover.
Fon du Lac	.....	Mains 6 to 7 ft. cover; services 5½ to 6½ ft. cover.
Milwaukee	.....	6 ft. cover.
Kenosha	.....	5½ ft. cover.
Cheyenne, Wyo.	.....	5 ft. cover.

McCLOSKEY TORCH COMPANY

337 20th Street, Toledo, Ohio

Manufacturers of Bomb Shell Torches

Products: Bomb Shell Torches.



McCloskey Bomb Shell Torches are positively the best danger signal made. They are *unbreakable, leak-proof, efficient, reliable, safe.*

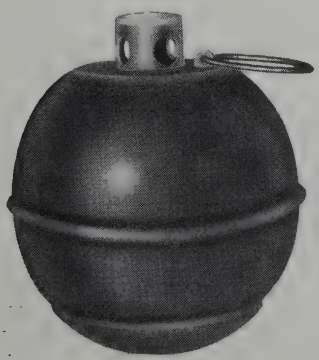
Are equipped with Cyclone burner and wick ready for instant use. Our cyclone burner which affords greater protection under all weather conditions also effects a great saving in fuel and wicks. Torches now being used without Cyclone burners can be equipped with this wonderful burner by means of our adapter, shown below, making any torch now in use interchangeable. On gross-lot orders we equip our torches with a brass nameplate, marked "Property of, etc.," free of charge. On smaller orders they will be furnished at cost.

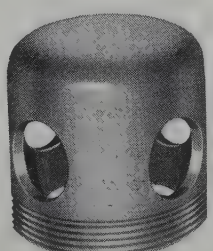
McCloskey Bomb Shell Torches are being used everywhere by State and County Highway Departments, Railway, Gas and Telephone Companies and by all progressive contractors and are being exported to all parts of the world.

McCloskey Torches will burn from Saturday night until Monday morning with just one filling. No barricading is necessary.

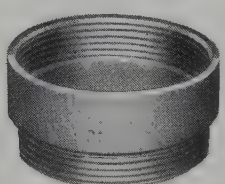
McCloskey Bomb Shell Torches are made in two halves, of rolled and pickled deep drawn steel and welded together. Cast iron counterweight pressed in bottom absolutely prevents them from being knocked over. They are never stolen—being suitable for construction work only. Are enthusiastically endorsed by insurance and bonding companies as they have reduced accident claims nearly 100 per cent because they remain lighted through the hardest wind and rain storms. The No. 1 size, which is of 4 quart capacity, is made of U. S. Standard 13 gauge steel. The No. 2 size, which is of 3 quart capacity, is made of U. S. Standard 15 gauge steel.

If your dealer does not handle torches write us, and we will supply you direct, as you cannot afford to be without this modern protection.





Cyclone Burner



Adapter for Earlier Models

Wick Holder

KALAMAZOO FOUNDRY & MACHINE COMPANY

580 East Main Street, Kalamazoo, Mich.

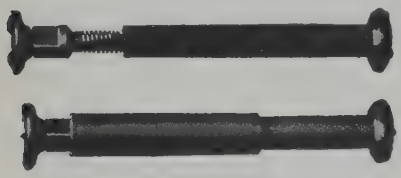
Kalamazoo Trenching Braces

Products: KALAMAZOO TRENCHING BRACES WITH FORGED STEEL SCREWS.

New List Subject to Discount
Barrels of Heavy Steel Pipe

NOTE:

Our Pipe Barrels are Heavy Steel Pipe that will stand the necessary rough use and NOT SPLIT



Style H Wrench FREE with every 2 dozen Style H G

Regular Trench Brace

1½ inch Heavy Steel Pipe Barrels
1¼ inch Steel Screw

Telegraph Code	Length When Closed	Extend Safely	Per Dozen	Weight Per Doz.
Hack	1 ft. 3 in.	7 in.	$24.88	130 lbs.
Habit	1 ft. 6 in.	10 in.	26.41	147 lbs.
Haft	1 ft. 9 in.	10 in.	27.80	157 lbs.
Hale	2 ft.	10 in.	29.18	161 lbs.
Hank	2 ft. 6 in.	10 in.	31.91	174 lbs.
Harp	3 ft.	10 in.	34.65	197 lbs.
Haul	3 ft. 6 in.	10 in.	37.40	215 lbs.
Hate	4 ft.	10 in.	40.15	232 lbs.
Guard	For Mud Guard add...		6.00	39 lbs.

Regular Heavy Trench Brace

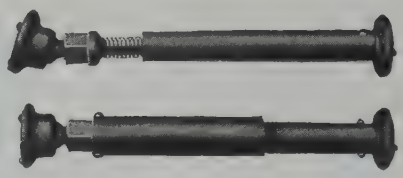
2 inch Heavy Steel Pipe Barrels
1½ inch Steel Screw Threaded 15 inches
Extend Safely 13 inches

Telegraph Code	Length When Closed	Price Per Doz.	Weight Per Doz.
Hepe	3 ft.	$43.61	296 lbs.
Hemp	3 ft. 6 in.	46.13	314 lbs.
Help	4 ft.	48.62	334 lbs.
Heke	4 ft. 6 in.	50.70	353 lbs.
Hear	5 ft.	53.73	374 lbs.
Hebe	5 ft. 6 in.	56.24	394 lbs.
Heck	6 ft.	58.76	413 lbs.
Hede	6 ft. 6 in.	61.24	432 lbs.
Guard	For Mud Guard add	12.00	80 lbs.

Ball and Socket Brace

1½ inch Heavy Steel Pipe Barrels
1¼ inch Steel Screw

Telegraph Code	Nominal Length	Actual Length Closed	Extend Safely	Price Per Doz.	Weight Per Doz.
Sabe	1 ft. 3 in.	1 ft. 4¾ in.	7 in.	$31.24	161 lbs.
Sace	1 ft. 6 in.	1 ft. 7¾ in.	10 in.	32.64	178 lbs.
Sade	1 ft. 9 in.	1 ft. 10¾ in.	10 in.	33.94	185 lbs.
Safe	2 ft.	2 ft. 1¾ in.	10 in.	35.25	192 lbs.
Sage	2 ft. 6 in.	2 ft. 7¾ in.	10 in.	37.87	210 lbs.
Sahe	3 ft.	3 ft. 1¾ in.	10 in.	40.47	226 lbs.
Saje	3 ft. 6 in.	3 ft. 7¾ in.	10 in.	43.07	245 lbs.
Sake	4 ft.	4 ft. 1¾ in.	10 in.	45.69	264 lbs.
Guard	For Mud Guard add			6.00	39 lbs.

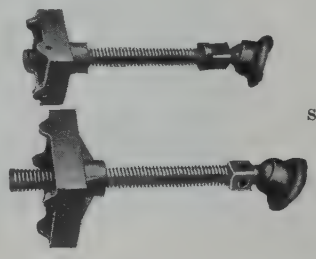


Style S Wrench FREE with every 2 dozen Style S G

Ball and Socket Heavy Brace

2 inch Heavy Steel Pipe Barrels
1½ inch Steel Screw Threaded 14 inches
Extend Safely 12 inches

Telegraph Code	Nominal Length	Actual Length Closed	Price Per Doz.	Weight Per Doz.
Sepe	3 ft.	3 ft. 2¼ in.	$52.07	323 lbs.
Seme	3 ft. 6 in.	3 ft. 8¼ in.	54.57	343 lbs.
Sele	4 ft.	4 ft. 2¼ in.	57.08	364 lbs.
Seke	4 ft. 6 in.	4 ft. 8¼ in.	59.57	385 lbs.
Sebe	5 ft.	5 ft. 2¼ in.	62.08	405 lbs.
Sece	5 ft. 6 in.	5 ft. 8¼ in.	64.57	425 lbs.
Sede	6 ft.	6 ft. 2¼ in.	67.08	444 lbs.
Sefe	6 ft. 6in.	6 ft. 8¼ in.	69.59	464 lbs.
Guard	For Mud Guard add		12.00	80 lbs.



Style T

Kalamazoo Timber Brace Fittings

Telegraph Code	Screw Inches	Timber	Extend Safely	Price Per. Doz. Plain Swivel	Weight Per Doz.
Plow	1¼	4x 4	10 in.	$24.80 Ball and Socket	142 lbs.
Thaw	1¼	4x 4	10 in.	30.05	173 lbs.
Time	1½	4x 4	12 in.	40.91	215 lbs.
Tiger	1½	6x 6	12 in.	47.83	300 lbs.
Trust	1¾	6x 6	12 in.	59.13	375 lbs.
Truth	1¾	8x 8	12 in.	66.37	430 lbs.
Trod	1¾	8x10	12 in.	69.58	460 lbs.

Style T Braces are suitable for use in any width trench except the narrowest. They are especially useful in wide excavations. Making the screws, as we do, of stiff steel, and bracing the caps as in our larger sizes, makes these Braces most desirable for heavy and severe service. Cutting thread in cap makes these so that they may be safely extended within two inches of length of thread on screw.

WEMLINGER, INC.

Steel Sheet Piling Specialists

Main Office: 149 Broadway, New York

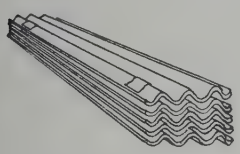
BRANCHES

Richmond, 204 N. Jefferson St. Boston, 31 State St. Chicago, 228 N. LaSalle St.

Products: STEEL SHEET PILING. CORRUGATED, ROLLED.

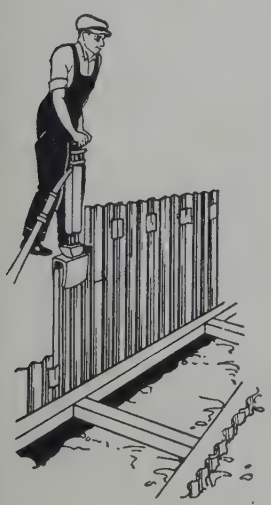
Nearly a quarter-century of specialized experience in this line. Expert advice and prompt service.

When an excavation is made in wet soil and must be kept free from water, it is highly advisable to use Wemlinger Corrugated Steel Sheet Piling rather than wooden sheeting. The corrugated steel sheets overlap and fit together closely, producing a tight interlock. Yet the short locking clip makes installation comparatively easy. Contractors who have used Wemlinger Sheeting for cofferdams or other wet excavation express complete satisfaction with it.



Space: In storage, or in transit from one job to another, Wemlinger Corrugated Steel Sheet Piling is economical of space. When piled up, the corrugated sections fit each other.

Re-Use: "We must have used our Corrugated sheeting at least 100 times," writes one contractor. While Wemlinger Corrugated Steel Sheet Piling may be used for permanent installations, its temporary use is an important economy because of the great number of times it can be driven and pulled.



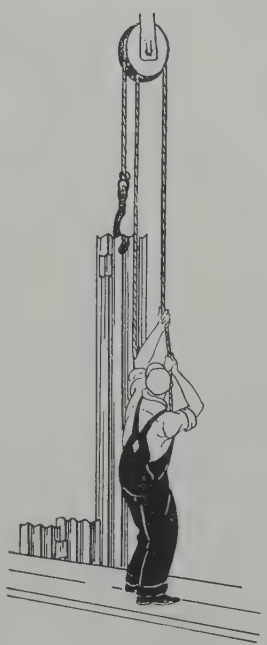
For Certain Kinds of Excavation: If your business involves the use of sheet piling, Wemlinger Corrugated sheeting should be a part of your permanent equipment. In any case it will pay you to write for information. If possible, please state the nature of the work you have to do.

Driving and Pulling: Although Wemlinger Corrugated Sheeting is light, it is also tough and with proper care can be driven by hand, air or steam without damage. In fact, it is often driven and pulled without special equipment. Because of the short interlocking clips the sections are not frozen together by hardened soil. This saves needless expense in pulling.

Labor: Wemlinger Corrugated sheeting is light and easily handled. The short clips, whereby the sections are

made interlocking, permit sidewise, interlock. The saving in labor is important.

Standard Makes: Besides Corrugated Sheeting we supply rolled steel sheet piling in all sizes and quantity.



Guarantee: If used, Steel Piling is furnished by us, the same is inspected at time of loading by one of our representatives; we guarantee the same to be in first class condition.

Rented: By the month for temporary installations.

Leased: At fixed price for duration of job.

Sold and Purchased: Any quantity, anywhere.

Tables for Friction of Water in Pipes

LOSS OF HEAD IN FEET DUE TO FRICTION PER 100 FEET OF 15-YEAR-OLD SMOOTH CAST IRON PIPE

From Standard of Hydraulic Society

Gal. per Min.	⅛ Inch Pipe		¼ Inch Pipe		⅜ Inch Pipe		½ Inch Pipe		¾ Inch Pipe		1 Inch Pipe		1¼ Inch Pipe		1½ Inch Pipe		2 Inch Pipe		2½ Inch Pipe		3 Inch Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
1	5.60	121	3.08	28	1.67	6.4	1.05	2.1														
2			6.16	103	3.35	23.3	2.10	7.4	1.20	1.9												
3					5.02	49.0	3.16	15.8	1.80	4.1	1.12	1.26										
4					5.76	84.0	4.21	27.0	2.41	7.0	1.49	2.14	0.86	0.57	0.63	0.26						
5					7.20	126.0	5.26	41.0	3.01	10.5	1.86	3.25	1.07	0.84	0.79	0.40						
10							10.52	147.0	6.02	38.0	3.72	11.7	2.14	3.05	1.57	1.43	1.02	0.50	0.65	0.17	0.45	0.07
15									9.02	80.0	5.60	25.0	3.2	6.50	2.36	3.0	1.53	1.08	0.98	0.36	0.68	0.15
20									12.03	136.0	7.44	42.0	4.29	11.1	3.15	5.2	2.04	1.82	1.31	0.61	0.91	0.25
25											9.30	64.0	5.36	16.6	3.94	7.8	2.55	2.73	1.63	0.92	1.13	0.38
30											11.15	89.0	6.43	23.5	4.72	11.0	3.06	3.84	1.96	1.29	1.36	0.54
35											13.02	119.0	7.51	31.2	5.51	14.7	3.57	5.1	2.29	1.72	1.59	0.71
40											14.88	152.0	8.58	40.0	6.3	18.8	4.08	6.6	2.61	2.20	1.82	0.91
45													9.65	50	7.08	23.2	4.60	8.2	2.94	2.80	2.05	1.15
50													10.72	60	7.87	28.4	5.11	9.9	3.27	3.32	2.27	1.38
70													15.01	113	11.02	53.0	7.15	18.4	4.58	6.21	3.18	2.57
75															11.80	60.0	7.66	20.9	5.01	7.1	3.4	3.05
100															15.74	102	10.21	35.8	6.54	12.0	4.54	4.96
120															18.89	143	12.25	50.0	7.84	16.8	5.45	7.0
125																	12.75	54	8.16	18.2	5.67	7.6
150																	15.32	76.0	9.80	25.5	6.8	10.5
175																	17.85	102	11.3	33.8	7.94	14.0
200																	20.4	129	13.07	43.1	9.08	17.8
225																			14.71	54.3	10.2	22.3
250																			16.3	66	11.32	27.2
270																					12.25	31.3
275																					12.50	32.5
300																					13.62	38.0

Vel. = Velocity ft. per second. Fric. = Friction Head in Feet.

LOSS OF HEAD IN FEET DUE TO FRICTION, PER 100 FEET OF 15-YEAR-OLD ORDINARY CAST IRON PIPE

Gals. per Min.	24 Inch Pipe		30 Inch Pipe		36 Inch Pipe		42 Inch Pipe		Gals. per Min.	24 Inch Pipe		30 Inch Pipe		36 Inch Pipe		42 Inch Pipe		48 Inch Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.		Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
									13000	9.22	1.63	5.91	0.54	4.10	0.22	3.00	0.10		
									13500	9.60	1.75	6.13	0.58	4.27	0.24	3.12	0.11		
									14000	9.95	1.87	6.36	0.63	4.43	0.26	3.23	0.12		
									14500	10.3	2.00	6.61	0.68	4.59	0.27	3.35	0.13	2.57	0.06
2000	1.42	0.05							15000	10.63	2.12	6.81	0.72	4.76	0.29	3.47	0.14	2.66	0.07
2500	1.77	0.07							16000	11.38	2.40	7.36	0.83	5.05	0.33	3.71	0.15	2.87	0.08
3000	2.13	0.10							17000	12.09	2.70	7.73	0.91	5.36	0.37	3.94	0.17	3.02	0.09
									18000	12.76	2.97	8.18	1.00	5.67	0.41	4.16	0.19	3.19	0.10
3500	2.49	0.14	1.56	0.04					19000	13.50	3.26	8.66	1.11	6.00	0.45	4.40	0.21	3.37	0.11
4000	2.85	0.18	1.81	0.06					20000	14.20	3.60	9.09	1.22	6.30	0.50	4.63	0.23	3.54	0.12
4500	3.20	0.22	2.04	0.08															
5000	3.54	0.27	2.26	0.09					21000	14.90	3.96	9.54	1.34	6.62	0.55	4.85	0.26	3.71	0.13
5500	3.90	0.33	2.50	0.11					22000			10.0	1.47	6.93	0.60	5.10	0.28	3.90	0.14
									23000			10.45	1.59	7.24	0.65	5.32	0.30	4.07	0.15
6000	4.25	0.38	2.72	0.13	1.90	0.05			24000			10.90	1.71	7.54	0.70	5.55	0.32	4.26	0.17
6500	4.61	0.45	2.95	0.15	2.05	0.06			25000			11.35	1.85	7.88	0.76	5.79	0.35	4.43	0.18
7000	4.97	0.52	3.18	0.17	2.21	0.07													
7500	5.32	0.59	3.42	0.20	2.37	0.08			26000			11.80	1.97	8.20	0.82	6.03	0.38	4.61	0.20
8000	5.68	0.66	3.63	0.22	2.53	0.09			27000			12.26	2.12	8.53	0.87	6.28	0.41	4.78	0.21
									28000			12.73	2.28	8.85	0.94	6.51	0.44	4.96	0.23
8500	6.03	0.74	3.86	0.25	2.69	0.10			29000					9.17	1.00	6.71	0.47	5.14	0.24
9000	6.35	0.81	4.08	0.27	2.84	0.11			30000					9.45	1.05	6.96	0.50	5.33	0.26
9500	6.74	0.91	4.31	0.30	3.00	0.12													
10000	7.07	0.98	4.54	0.33	3.14	0.13	2.31	0.06	32000					10.10	1.19	7.42	0.56	5.67	0.29
10500	7.45	1.10	4.76	0.37	3.26	0.14	2.43	0.06	34000					10.75	1.33	7.88	0.63	6.03	0.33
									36000					11.38	1.49	8.32	0.70	6.39	0.37
11000	7.80	1.20	5.00	0.40	3.46	0.16	2.55	0.07	38000					12.00	1.65	8.80	0.77	6.75	0.40
11500	8.16	1.29	5.21	0.43	3.62	0.18	2.65	0.08	40000					12.62	1.81	9.28	0.85	7.11	0.44
12000	8.50	1.40	5.44	0.47	3.77	0.19	2.77	0.09											
12500	8.86	1.52	5.67	0.51	3.94	0.21	2.89	0.09	42000					13.25	1.99	9.75	0.93	7.45	0.49

Vel. = Velocity ft. per second. Fric. = Friction Head in Feet.

FRICTION OF WATER IN 90° ELBOWS AND EQUIVALENT NUMBER OF FEET STRAIGHT PIPE

Size of Elbow, Inches	24	30	36	42	48
Friction Equivalent Feet Straight Pipe	80	100	120	140	160

Size of Elbow, Inches	⅛	¼	⅜
Friction Equivalent Feet Straight Pipe	2	3	4

Tables for Friction of Water in Pipes

Loss of Head in Feet Due to Friction, Per 100 Feet of 15-Year-Old Ordinary Cast Iron Pipe

From Standard of Hydraulic Society

Gal. per Min.	4 Inch Pipe		5 Inch Pipe		6 Inch Pipe		8 Inch Pipe		10 Inch Pipe		12 Inch Pipe		14 Inch Pipe		15 Inch Pipe		16 Inch Pipe		20 Inch Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
40	1.02	0.22																		
45	1.17	0.28																		
50	1.28	0.34																		
70	1.79	0.63	1.14	0.21																
75	1.92	0.73	1.22	0.24																
100	2.55	1.22	1.63	0.41	1.14	0.14														
120	3.06	1.71	1.96	0.58	1.42	0.25														
125	3.19	1.86	2.04	0.64	1.48	0.28														
150	3.84	2.55	2.45	0.88	1.71	0.32														
175	4.45	3.44	2.86	1.18	2.00	0.48														
200	5.11	4.40	3.27	1.48	2.28	0.62														
225	5.77	5.45	3.67	1.86	2.57	0.74														
250	6.40	6.72	4.08	2.24	2.80	0.92	1.60	0.22												
270	6.90	7.70	4.42	2.60	3.03	1.13	1.70	0.25												
275	7.03	7.99	4.50	2.72	3.06	1.15	1.73	0.27												
300	7.66	9.30	4.90	3.14	3.40	1.29	1.90	0.32												
350	8.90	12.32	5.72	4.19	3.98	1.75	2.20	0.42												
400	10.21	16.00	6.54	5.40	4.54	2.21	2.60	0.54												
450	11.50	19.80	7.35	6.70	5.12	2.65	2.92	0.68	1.80	0.21										
470	12.10	22.40	7.70	7.22	5.49	2.90	3.07	0.75	1.92	0.24										
475	12.20	22.96	7.76	7.42	5.55	2.95	3.10	0.76	1.94	0.25										
500	12.77	24.00	8.17	8.12	5.60	3.30	3.20	0.82	2.04	0.28	1.42	0.11								
550	....	....	8.99	9.60	6.16	3.93	3.52	0.97	2.25	0.33	1.57	0.14								
600	....	....	9.80	11.30	6.72	4.70	3.84	1.14	2.46	0.39	1.71	0.15								
650	....	....	10.62	13.20	7.28	5.40	4.16	1.34	2.66	0.46	1.85	0.19	1.37	0.09						
700	....	....	11.44	15.10	7.84	6.20	4.46	1.54	2.86	0.52	2.00	0.22	1.47	0.10						
750	....	....	12.26	17.20	8.50	7.00	4.80	1.74	3.06	0.59	2.13	0.24	1.58	0.11						
800	....	....	....	....	9.08	8.00	5.12	1.97	3.28	0.67	2.27	0.27	1.68	0.13						
850	....	....	....	....	9.58	8.95	5.48	2.28	3.48	0.75	2.41	0.31	1.79	0.14						
900	....	....	....	....	10.30	10.11	5.75	2.46	3.68	0.83	2.56	0.34	1.89	0.16						
950	....	....	....	....	10.72	10.80	6.06	2.87	3.88	0.91	2.70	0.38	2.00	0.18	1.73	0.12				
1000	....	....	....	....	11.32	12.04	6.40	3.02	4.08	1.01	2.84	0.41	2.10	0.19	1.82	0.14				
1050	....	....	....	....	11.90	13.30	6.70	3.21	4.29	1.09	2.98	0.44	2.20	0.22	1.91	0.16				
1100	....	....	....	....	12.50	14.31	7.03	3.51	4.50	1.20	3.13	0.49	2.31	0.23	2.00	0.17				
1150	....	....	....	....	12.95	15.60	7.35	3.84	4.71	1.34	3.27	0.53	2.42	0.25	2.09	0.18				
1200	....	....	....	....	13.52	16.69	7.67	4.15	4.91	1.46	3.41	0.57	2.52	0.26	2.18	0.19				
1250	....	....	....	....	14.10	18.50	8.00	4.45	5.11	1.51	3.55	0.62	2.63	0.29	2.28	0.20	1.99	0.15		
1500	....	....	....	....	....	....	9.60	6.27	6.10	2.09	4.20	0.85	3.15	0.39	2.73	0.28	2.39	0.21		
2000	....	....	....	....	....	....	12.70	10.71	8.10	3.65	5.60	1.43	4.20	0.66	3.64	0.54	3.19	0.39		
2500	....	....	....	....	....	....	....	....	10.10	5.33	7.00	2.28	5.25	1.01	4.55	0.72	3.99	0.56		
3000	....	....	....	....	....	....	....	....	12.10	7.80	8.40	3.15	6.30	1.47	5.46	1.12	4.79	0.80	3.08	0.27
3500	....	....	....	....	....	....	....	....	14.10	10.08	9.80	4.10	7.35	1.81	6.37	1.43	5.59	1.04	3.59	0.35
4000	....	....	....	....	....	....	....	....	....	....	11.35	5.32	8.40	2.47	7.28	1.85	6.38	1.34	4.10	0.45
4200	....	....	....	....	....	....	....	....	....	....	11.93	6.00	8.82	2.80	7.64	2.08	6.72	1.45	4.32	0.50
4500	....	....	....	....	....	....	....	....	....	....	12.78	6.90	9.45	3.22	8.19	2.23	7.20	1.65	4.62	0.56
5000	....	....	....	....	....	....	....	....	....	....	14.20	8.40	10.50	3.92	9.10	2.78	7.96	2.02	5.13	0.68
5500	....	....	....	....	....	....	....	....	....	....	....	....	11.55	4.65	10.01	3.30	8.78	2.39	5.64	0.82
6000	....	....	....	....	....	....	....	....	....	....	....	....	12.60	5.50	10.92	3.90	9.56	2.60	6.15	0.96
6500	....	....	....	....	....	....	....	....	....	....	....	....	13.65	6.45	11.83	4.55	10.36	3.32	6.66	1.06
7000	....	....	....	....	....	....	....	....	....	....	....	....	14.70	7.15	12.74	5.08	11.12	3.68	7.18	1.28
7200	....	....	....	....	....	....	....	....	....	....	....	....	....	....	13.10	5.45	11.50	3.96	7.38	1.35
7500	....	....	....	....	....	....	....	....	....	....	....	....	....	....	13.65	5.90	11.95	4.28	7.66	1.45
8000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8.17	1.63
8500	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8.68	1.83
9000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	9.20	2.04
9500	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	9.70	2.23
10000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10.40	2.53

Vel.—Velocity ft. per second. Fric.—Friction Head in Feet.

Friction of Water in 90° Elbows and Equivalent Number of Feet Straight Pipe

From Standard of Hydraulic Society

Size of Elbow, Inches	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12	14	15	16	20
Friction Equivalent Feet Straight Pipe	5	6	6	8	8	8	11	15	16	18	18	24	30	40	54	55	55	70

Relative Carrying Capacities of Pipe Lines of Equal Smoothness

Prepared by Emil L. Nuebling for the Reading Meter Repair Co.

Diameter of Pipes	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½
26										348.81
24										285.55
22										229.20
20									316.23	181.02
18									243.00	139.10
16								371.60	181.02	103.62
15								316.23	154.05	88.18
14							419.80	266.13	129.64	74.21
12							285.55	181.02	88.18	50.48
10						316.23	181.02	114.76	55.90	32.00
9						243.00	139.10	88.18	42.96	24.65
8					371.60	181.02	103.62	65.69	32.00	18.32
7					266.13	129.64	74.21	47.05	22.92	13.12
6					181.02	88.18	50.48	32.00	15.59	8.92
5				316.23	114.76	55.90	32.00	20.29	9.88	5.66
4½				243.00	88.18	42.96	24.65	15.59	7.59	4.35
4			371.60	181.02	65.69	32.00	18.32	11.61	5.66	3.24
3½			266.13	129.64	47.05	22.92	13.12	8.32	4.05	2.32
3			181.02	88.18	32.00	15.59	8.92	5.66	2.76	1.58
2½		316.23	114.76	55.90	20.29	9.88	5.66	3.59	1.75	1.00
2		181.02	65.69	32.00	11.61	5.66	3.24	2.05	1.00	
1½		88.18	32.00	15.59	5.66	2.76	1.58	1.00		
1¼	316.23	55.90	20.29	9.88	3.59	1.75	1.00			
1	181.02	32.00	11.61	5.66	2.05	1.00				
¾	88.18	15.59	5.66	2.05	1.00					
½	32.00	5.66	2.05	1.00						
⅜	15.59	2.76	1.00							
¼	5.66	1.00								
⅛	1.00									

Diameter of Pipes	3	3½	4	4½	5	6	7	8	9	10
48			498.83	371.60	285.55	181.02	123.13	88.18	65.69	50.48
46			448.48	334.09	256.73	162.75	110.70	79.10	59.06	45.38
44			401.31	298.96	229.20	145.63	99.29	70.94	52.85	40.61
42			357.25	243.00	204.50	129.64	88.18	63.15	47.05	36.15
40			316.23	235.57	181.02	114.76	78.06	55.90	41.64	32.00
38		388.41	278.17	207.22	159.23	100.94	68.66	49.17	36.63	28.15
36		339.30	243.00	181.02	139.10	88.18	59.98	42.96	32.00	24.65
34		294.12	210.64	156.92	120.58	76.44	51.99	37.24	27.74	21.32
32		252.76	181.02	134.85	103.62	65.69	44.68	32.00	23.84	18.32
30	316.23	215.10	154.05	114.76	88.18	55.90	38.02	27.23	20.29	15.59
28	266.13	181.02	129.64	96.57	74.21	47.05	32.00	22.92	17.07	13.12
26	221.12	150.41	107.72	80.24	61.66	39.09	26.59	19.04	14.18	10.90
24	181.02	123.13	88.18	65.69	50.48	32.00	21.77	15.59	11.61	8.92
22	145.63	99.29	70.94	52.85	40.61	25.74	17.51	12.54	9.34	7.18
20	114.76	78.06	55.90	41.64	32.00	20.29	13.80	9.88	7.36	5.66
18	88.18	59.98	42.96	32.00	24.65	15.59	10.60	7.59	5.66	4.35
16	65.69	44.68	32.00	23.84	18.32	11.61	7.90	5.66	4.21	3.24
15	55.90	38.02	27.23	20.29	15.59	9.88	6.72	4.81	3.59	2.76
14	47.05	32.00	22.92	17.07	13.12	8.32	5.66	4.05	3.02	2.32
12	32.00	21.77	15.59	11.61	8.92	5.66	3.85	2.76	2.05	1.58
10	20.29	13.80	9.88	7.36	5.66	3.59	2.44	1.75	1.30	1.00
9	15.59	10.60	7.59	5.66	4.35	2.76	1.83	1.34	1.00	
8	11.61	7.90	5.66	4.21	3.24	2.05	1.40	1.00		
7	8.32	5.66	4.05	3.02	2.32	1.47	1.00			
6	5.66	3.85	2.76	2.05	1.58	1.00				
5	3.59	2.44	1.77	1.30	1.00					
4½	2.76	1.83	1.34	1.00						
4	2.05	1.40	1.00							
3½	1.47	1.00								
3	1.00									

Diameter of Pipes	12	14	15	16	18	20	22	24	26	28
48	32.00	21.77	18.32	15.59	11.61	8.92	7.03	5.66	4.63	3.85
46	28.77	19.57	16.47	14.02	10.44	8.02	6.32	5.09	4.16	3.46
44	25.74	17.51	14.71	12.54	9.34	7.17	5.66	4.55	3.73	3.10
42	22.92	15.59	13.12	11.16	8.32	6.39	5.04	4.05	3.32	2.76
40	20.29	13.80	11.61	9.88	7.36	5.66	4.46	3.59	2.94	2.44
38	17.84	12.14	10.21	8.69	6.48	4.98	3.92	3.15	2.58	2.17
36	15.59	10.60	8.92	7.59	5.66	4.35	3.43	2.76	2.26	1.83
34	13.51	9.19	7.74	6.58	4.90	3.77	2.97	2.39	1.96	1.62
32	11.61	7.90	6.65	5.66	4.21	3.24	2.55	2.05	1.68	1.40
30	9.88	6.72	5.66	4.81	3.59	2.76	2.17	1.75	1.43	1.19
28	8.32	5.66	4.76	4.05	3.02	2.32	1.83	1.47	1.20	1.00
26	6.91	4.70	3.96	3.37	2.51	1.93	1.52	1.22	1.00	
24	5.66	3.85	3.24	2.76	2.05	1.58	1.24	1.00		
22	4.55	3.10	2.61	2.22	1.65	1.27	1.00			
20	3.59	2.44	2.05	1.75	1.30	1.00				
18	2.76	1.83	1.58	1.34	1.00					
16	2.05	1.40	1.18	1.00						
15	1.75	1.19	1.00							
14	1.47	1.00								
12	1.00									

Diameter of Pipes	30	32	34	36	38	40	42	44	46	48
48	3.24	2.76	2.37	2.05	1.80	1.58	1.40	1.24	1.11	1.00
46	2.91	2.48	2.13	1.85	1.61	1.42	1.26	1.12	1.00	
44	2.61	2.22	1.91	1.65	1.44	1.27	1.12	1.00		
42	2.32	1.97	1.70	1.47	1.28	1.13	1.00			
40	2.05	1.75	1.50	1.30	1.14	1.00				
38	1.81	1.54	1.32	1.14	1.00					
36	1.58	1.34	1.15	1.00						
34	1.37	1.16	1.00							
32	1.18	1.00								
30	1.00									

The foregoing tables will be found useful in proportioning distribution lines.

Example: To find how many one-half inch pipes can be supplied by a 4-in. line, follow down the ½-in. vertical column to the number opposite 4-in. diameter of the first column, where the number 181.02 is found, which is the number of one-half inch lines that can be supplied by a 4-in. line.

Example: To find how many 12-in. lines can be supplied by a 48-in. line, follow horizontally along the 48-in. diameter of the first column, until you reach the 12-in. vertical column, where the number 32 is found, which is the result desired.

INCHES IN DECIMALS OF A FOOT

Fraction of an inch	1/16	3/32	⅛	5/16	¼	9/32	⅓	½	5/8	¼	⅞
Decimal of a foot	.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729
Inches	1	2	3	4	5	6	7	8	9	10	11
Decimal of a foot	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

Loss of Head Tables

From Handbook American Cast Iron Pipe Co.

LOSS OF HEAD IN PIPES BY FRICTION

Loss of head by friction in each 100 feet in length of different diameters of pipe when discharging the following quantities of water per minute. (Pelton Water-wheel Co.)

Velocity in feet per second V	Inside Diameter of Pipe in Inches: 4 — Loss of head in feet h	4 — Cubic feet per minute Q	6 — Loss of head in feet h	6 — Cubic feet per minute Q	8 — Loss of head in feet h	8 — Cubic feet per minute Q	10 — Loss of head in feet h	10 — Cubic feet per minute Q	12 — Loss of head in feet h	12 — Cubic feet per minute Q
2.0	.593	10.4	.395	23.5	.296	41.9	.237	65.4	198	94.2
3.0	1.22	15.7	815	35.3	.611	62.8	.488	98.2	407	141.
4.0	2.05	20.9	1.37	47.1	1.027	83 7	.822	131.	.685	188.
5.0	3.08	26.2	2.05	58.9	1.54	105	1.23	163.	1.028	235.
6.0	4.31	31.4	2.87	70.7	2.15	125	1.71	196.	1.43	283.
7.0	5.72	36.6	3 81	82.4	2.85	146	2.28	229.	1.91	330.

	14 — Loss of head in feet h	14 — Cubic feet per minute Q	16 — Loss of head in feet h	16 — Cubic feet per minute Q	20 — Loss of head in feet h	20 — Cubic feet per minute Q	24 — Loss of head in feet h	24 — Cubic feet per minute Q	30 — Loss of head in feet h	30 — Cubic feet per minute Q
2.0	.169	128	147	167	119	262	.098	.377	.079	589
3.0	.349	192	303	251	245	393	.204	565	163	883
4.0	.587	256	513	335	410	523	.342	754	.273	1178
5.0	.881	321	770	419	617	654	.513	942	411	1472
6.0	1 229	385	1.076	502	861	785	.717	1131	.574	1767
7.0	1.63	449	1 43	586	1.143	916	.953	1319	.762	2061

Example.—Given 200 feet head and 600 feet of 12-inch pipe, carrying 141 cubic feet of water per minute. To find effective head. In right-hand column, under 12-inch pipe, find 141 cubic feet; opposite this will be found the loss by friction in 100 feet length for this amount of water, which is .407 Multiply this by the number of hundred feet of pipe, which is 6, and we have 2.44 feet, which is the loss of head.

Therefore, the effective head is 200 minus 2.44 is 197.56

FRICTION OF WATER IN PIPES

Loss in pounds pressure per square inch by friction for each 100 feet of straight smooth pipe, discharging the stated quantities per minute

U. S Gallons	SIZES OF PIPE: 1 in.	2½ in.	2 in.	2½ in.	3 in	4 in.	6 in.	8 in.	10 in.	12 in.	14 in	16 in.	18 in	20 in.	24 in	30 in.	Imp. Gallons
5	0.84	0.12															4
10	3 16	0.47	0.12														8
15	6 98	0.97	0 27														12
20	12.3	1.66	0.42														16
25	19.0	2.62	0.67	0.21													20
30	27 5	3.75	0.91	0 30													25
35	37 0	5.05	1.26	0 42	0.14												29
40	48 0	6.52	1.60	0.51	0.17												33
45		8.15	2.01	0.61	0.27												37
50		10.0	2.44	0 81	0.35	0.09											41
75		22.4	5.32	1.80	0.74	0.21											62
100		39.0.	9.46	3.20	1 31	0 33	0.05										83
125		48.1	14.9	4 89	1.99	0.51	0 07										103
150			21.2	7.00	2.85	0.69	0 10	0 02									124
175			28 1	9.46	3.85	0.95	0 14	0 03									145
200			37.5	12.47	5.02	1.22	0 17	0 04	0 01								166
250			47.7	19.66	7.76	1 89	0.26	0 06	0 02								207
300				28.06	11.20	2.66	0.37	0 09	0.03	0 005							249
350				33.41	15.20	3 65	0.50	0 11	0 05	0 007	004						290
400				42.96	19.50	4 73	0.65	0 15	0 06	0 010	005	.001					332
450					25.00	6 01	0.81	0 20	0 08	0.020	008	004					373
500					30 80	7 43	0.96	0 25	0 09	0 041	017	009	005				415
600						9 54	1 41	0 39	0 14	0 070	026	014	007				500
700						14 32	1 89	0.47	0.18	0 080	034	017	010	002			583
800							2.39	0 61	0.22	0.090	045	023	012	004			666
900							2.60	0 78	0.27	0 110	.055	028	015	.008	.001		749
1000							3 88	0 94	0.32	0.130	.062	036	020	.012	.005	.002	830
1250								1 46	0 49	0.200	.091	049	028	.021	009	.003	1037

Interest and Annuity Tables

From Handbook Cast Iron Pipe Publicity Bureau

COMPOUND INTEREST TABLE

Giving Value of $1 at End of Any Year, From 1 to 100

Years	4%	4½%	5%	5½%	6%	6½%	7%
1	1.0400	1.0450	1.0500	1.0550	1.0600	1.0650	1.0700
2	1.0816	1.0920	1.1025	1.1130	1.1236	1.1342	1.1449
3	1.1249	1.1412	1.1576	1.1742	1.1910	1.2079	1.2250
4	1.1699	1.1925	1.2155	1.2388	1.2625	1.2865	1.3108
5	1.2167	1.2462	1.2763	1.3070	1.3382	1.3701	1.4026
6	1.2653	1.3023	1.3401	1.3788	1.4185	1.4591	1.5007
7	1.3159	1.3609	1.4071	1.4547	1.5036	1.5540	1.6058
8	1.3686	1.4221	1.4775	1.5347	1.5938	1.6550	1.7182
9	1.4233	1.4861	1.5513	1.6191	1.6895	1.7626	1.8385
10	1.4802	1.5530	1.6289	1.7081	1.7908	1.8771	1.9672
11	1.5395	1.6229	1.7103	1.8021	1.8983	1.9992	2.1049
12	1.6010	1.6959	1.7959	1.9012	2.0122	2.1291	2.2522
13	1.6651	1.7722	1.8856	2.0058	2.1329	2.2675	2.4098
14	1.7317	1.8519	1.9799	2.1161	2.2609	2.4149	2.5785
15	1.8009	1.9353	2.0789	2.2325	2.3966	2.5718	2.7590
16	1.8730	2.0224	2.1829	2.3553	2.5404	2.7390	2.9522
17	1.9479	2.1134	2.2920	2.4848	2.6928	2.9170	3.1588
18	2.0258	2.2085	2.4066	2.6215	2.8543	3.1067	3.3799
19	2.1068	2.3079	2.5270	2.7656	3.0256	3.3086	3.6165
20	2.1911	2.4117	2.6533	2.9178	3.2071	3.5236	3.8697
21	2.2788	2.5202	2.7860	3.0782	3.3996	3.7527	4.1406
22	2.3699	2.6337	2.9253	3.2475	3.6035	3.9966	4.4304
23	2.4647	2.7522	3.0715	3.4262	3.8197	4.2564	4.7405
24	2.5633	2.8760	3.2251	3.6146	4.0489	4.5331	5.0724
25	2.6658	3.0054	3.3864	3.8134	4.2919	4.8277	5.4274
26	2.7725	3.1407	3.5557	4.0231	4.5494	5.1415	5.8074
27	2.8834	3.2820	3.7335	4.2444	4.8223	5.4757	6.2139
28	2.9987	3.4297	3.9201	4.4778	5.1117	5.8316	6.6488
29	3.1187	3.5840	4.1161	4.7241	5.4184	6.2107	7.1143
30	3.2434	3.7453	4.3219	4.9840	5.7435	6.6144	7.6123
31	3.3731	3.9139	4.5380	5.2581	6.0881	7.0443	8.1451
32	3.5081	4.0900	4.7649	5.5473	6.4534	7.5022	8.7153
33	3.6484	4.2740	5.0032	5.8524	6.8406	7.9898	9.3253
34	3.7943	4.4664	5.2533	6.1742	7.2510	8.5092	9.9781
35	3.9461	4.6673	5.5160	6.5138	7.6861	9.0623	10.6766
36	4.1039	4.8774	5.7918	6.8721	8.1473	9.6513	11.4239
37	4.2681	5.0969	6.0814	7.2501	8.6361	10.2786	12.2236
38	4.4388	5.3262	6.3855	7.6488	9.1543	10.9467	13.0793
39	4.6164	5.5659	6.7048	8.0695	9.7035	11.6583	13.9948
40	4.8010	5.8164	7.0400	8.5133	10.2857	12.4161	14.9745
41	4.9931	6.0781	7.3920	8.9815	10.9029	13.2231	16.0227
42	5.1928	6.3516	7.7616	9.4755	11.5570	14.0826	17.1443
43	5.4005	6.6374	8.1497	9.9967	12.2505	14.9980	18.3444
44	5.6165	6.9361	8.5572	10.5465	12.9855	15.9729	19.6285
45	5.8412	7.2482	8.9850	11.1266	13.7646	17.0111	21.0025
46	6.0748	7.5744	9.4343	11.7385	14.5905	18.1168	22.4726
47	6.3178	7.9153	9.9060	12.3841	15.4659	19.2944	24.0457
48	6.5705	8.2715	10.4013	13.0653	16.3939	20.5485	25.7289
49	6.8333	8.6437	10.9213	13.7838	17.3775	21.8842	27.5299
50	7.1067	9.0326	11.4674	14.5420	18.4202	23.3067	29.4570
51	7.3910	9.4391	12.0408	15.3418	19.5254	24.8216	31.5190
52	7.6866	9.8639	12.6428	16.1856	20.6969	26.4350	33.7253
53	7.9941	10.3077	13.2749	17.0758	21.9387	28.1533	36.0861
54	8.3138	10.7716	13.9387	18.0149	23.2550	29.9833	38.6122
55	8.6464	11.2563	14.6356	19.0058	24.6503	31.9322	41.3150
56	8.9922	11.7628	15.3674	20.0511	26.1293	34.0078	44.2071
57	9.3519	12.2922	16.1358	21.1539	27.6971	36.2183	47.3015
58	9.7260	12.8455	16.9426	22.3174	29.3589	38.5725	50.6127
59	10.1150	13.4234	17.7897	23.5448	31.1205	41.0797	54.1555
60	10.5196	14.0274	18.6792	24.8398	32.9877	43.7498	57.9464
61	10.9404	14.6586	19.6131	26.2060	34.9670	46.5936	62.0027
62	11.3780	15.3183	20.5938	27.6473	37.0650	49.6222	66.3429
63	11.8332	16.0076	21.6235	29.1679	39.2889	52.8476	70.9869
64	12.3065	16.7279	22.7047	30.7721	41.6462	56.2827	75.9559
65	12.7987	17.4807	23.8399	32.4646	44.1450	59.9411	81.2729
66	13.3107	18.2673	25.0319	34.2501	46.7937	63.8372	86.9620
67	13.8431	19.0894	26.2835	36.1339	49.6013	67.9867	93.0493
68	14.3968	19.9484	27.5977	38.1213	52.5774	72.4058	99.5627
69	14.9727	20.8461	28.9775	40.2179	55.7320	77.1122	106.5321
70	15.5716	21.7841	30.4264	42.4299	59.0759	82.1245	113.9894
71	16.1945	22.7644	31.9477	44.7636	62.6205	87.4626	121.9686
72	16.8423	23.7888	33.5451	47.2256	66.3777	93.1476	130.5065
73	17.5160	24.8593	35.2224	49.8230	70.3604	99.2022	139.6419
74	18.2166	25.9780	36.9835	52.5632	74.5820	105.6504	149.4168
75	18.9453	27.1470	38.8327	55.4542	79.0569	112.5176	159.8760
76	19.7031	28.3686	40.7743	58.5042	83.8003	119.8313	171.0673
77	20.4912	29.6452	42.8130	61.7219	88.8284	127.6203	183.0421
78	21.3108	30.9792	44.9537	65.1166	94.1581	135.9156	195.8550
79	22.1633	32.3733	47.2014	68.6980	99.8075	144.7501	209.5648
80	23.0498	33.8301	49.5614	72.4764	105.7960	154.1589	224.2344
81	23.9718	35.3525	52.0395	76.4626	112.1438	164.1792	239.9308
82	24.9307	36.9433	54.6415	80.6681	118.8724	174.8509	256.7260
83	25.9279	38.6058	57.3736	85.1048	126.0047	186.2162	274.6968
84	26.9650	40.3430	60.2422	89.7856	133.5650	198.3202	293.9255
85	28.0436	42.1585	63.2544	94.7238	141.5789	211.2111	314.5003
86	29.1653	44.0556	66.4171	99.9336	150.0736	224.9398	336.5154
87	30.3320	46.0381	69.7379	105.4299	159.0781	239.5609	360.0714
88	31.5452	48.1098	73.2248	111.2286	168.6227	255.1323	385.2764
89	32.8071	50.2747	76.8861	117.3462	178.7401	271.7159	412.2458
90	34.1193	52.5371	80.7304	123.8002	189.4645	289.3775	441.1030
91	35.4841	54.9013	84.7669	130.6092	200.8324	308.1870	471.9802
92	36.9035	57.3718	89.0052	137.7927	212.8823	328.2191	505.0188
93	38.3796	59.9536	93.4555	145.3713	225.6553	349.5534	540.3701
94	39.9148	62.6515	98.1283	153.3667	239.1946	372.2744	578.1960
95	41.5114	65.4708	103.0347	161.8019	253.5463	396.4722	618.6697
96	43.1718	68.4170	108.1864	170.7010	268.7590	422.2429	661.9766
97	44.8987	71.4957	113.5957	180.0896	284.8846	449.6887	708.3150
98	46.6947	74.7130	119.2755	189.9945	301.9776	478.9184	757.8970
99	48.5625	78.0751	125.2393	200.4442	320.0963	510.0481	810.9498
100	50.5049	81.5885	131.5013	211.4686	339.3021	543.2013	867.7163

ANNUITY TABLE

Giving Yearly Payments Required to Redeem $100 (Per Cent.) at End of Any Year, From 1 to 100

Years	2½%	3%	3½%	4%	4½%	5%	6%
1	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2	49.38	49.26	49.14	49.02	48.90	48.78	48.54
3	32.51	32.36	32.19	32.03	31.88	31.72	31.41
4	24.08	23.90	23.73	23.55	23.37	23.20	22.86
5	19.02	18.84	18.65	18.46	18.28	18.10	17.74
6	15.65	15.46	15.27	15.08	14.89	14.70	14.34
7	13.25	13.05	12.85	12.66	12.47	12.28	11.91
8	11.45	11.25	11.05	10.85	10.66	10.47	10.10
9	10.05	9.84	9.64	9.45	9.26	9.07	8.70
10	8.93	8.72	8.52	8.33	8.14	7.95	7.59
11	8.01	7.81	7.61	7.42	7.23	7.04	6.68
12	7.25	7.05	6.85	6.66	6.47	6.28	5.93
13	6.60	6.40	6.21	6.01	5.83	5.65	5.30
14	6.05	5.85	5.66	5.47	5.28	5.10	4.76
15	5.58	5.38	5.18	4.99	4.81	4.63	4.30
16	5.16	4.96	4.77	4.58	4.40	4.23	3.90
17	4.79	4.60	4.40	4.22	4.04	3.87	3.54
18	4.47	4.27	4.08	3.90	3.72	3.55	3.24
19	4.18	3.98	3.79	3.61	3.44	3.27	2.96
20	3.91	3.72	3.54	3.36	3.19	3.02	2.72
21	3.68	3.49	3.30	3.13	2.96	2.80	2.50
22	3.46	3.27	3.09	2.92	2.75	2.60	2.30
23	3.27	3.08	2.90	2.73	2.57	2.41	2.13
24	3.09	2.90	2.73	2.56	2.40	2.25	1.97
25	2.93	2.74	2.57	2.40	2.24	2.10	1.82
26	2.78	2.59	2.42	2.26	2.10	1.96	1.69
27	2.64	2.46	2.29	2.12	1.97	1.83	1.57
28	2.51	2.33	2.16	2.00	1.85	1.71	1.46
29	2.39	2.21	2.04	1.89	1.74	1.60	1.36
30	2.28	2.10	1.94	1.78	1.64	1.51	1.26
31	2.17	2.00	1.84	1.69	1.54	1.41	1.18
32	2.08	1.90	1.74	1.60	1.46	1.33	1.10
33	1.99	1.82	1.66	1.51	1.37	1.25	1.03
34	1.90	1.73	1.58	1.43	1.30	1.18	.96
35	1.82	1.65	1.50	1.36	1.23	1.11	.90
36	1.75	1.58	1.43	1.29	1.16	1.04	.84
37	1.67	1.51	1.36	1.22	1.10	.98	.79
38	1.61	1.45	1.30	1.16	1.04	.93	.74
39	1.54	1.38	1.24	1.11	.99	.88	.69
40	1.48	1.33	1.18	1.05	.93	.83	.65
41	1.43	1.27	1.13	1.00	.89	.78	.61
42	1.37	1.22	1.08	.95	.84	.74	.57
43	1.32	1.17	1.03	.91	.80	.70	.53
44	1.27	1.12	.99	.87	.76	.66	.50
45	1.23	1.08	.95	.83	.72	.63	.47
46	1.18	1.04	.91	.79	.68	.59	.44
47	1.14	1.00	.87	.75	.65	.56	.41
48	1.10	.96	.83	.72	.62	.53	.39
49	1.06	.92	.80	.69	.59	.50	.37
50	1.03	.89	.76	.66	.56	.48	.34
51	.99	.85	.73	.63	.53	.45	.32
52	.96	.82	.70	.60	.51	.43	.30
53	.93	.79	.67	.57	.48	.41	.29
54	.89	.76	.65	.55	.46	.39	.27
55	.87	.73	.62	.52	.44	.37	.25
56	.84	.71	.60	.50	.42	.35	.24
57	.81	.68	.57	.48	.40	.33	.22
58	.78	.66	.55	.46	.38	.31	.21
59	.76	.64	.53	.44	.36	.30	.20
60	.74	.61	.51	.42	.35	.28	.19
61	.71	.59	.49	.40	.33	.27	.18
62	.69	.57	.47	.39	.31	.26	.17
63	.67	.55	.45	.37	.30	.24	.16
64	.65	.53	.44	.35	.29	.23	.15
65	.63	.51	.42	.34	.27	.22	.14
66	.61	.50	.40	.32	.26	.21	.13
67	.59	.48	.39	.31	.25	.20	.12
68	.57	.46	.37	.30	.24	.19	.12
69	.56	.45	.36	.29	.23	.18	.11
70	.54	.43	.35	.27	.22	.17	.10
71	.52	.42	.33	.26	.21	.16	.10
72	.51	.41	.32	.25	.20	.15	.09
73	.49	.39	.31	.24	.19	.15	.09
74	.48	.38	.30	.23	.18	.14	.08
75	.47	.37	.29	.22	.17	.13	.08
76	.45	.35	.28	.21	.16	.13	.07
77	.44	.34	.27	.21	.16	.12	.07
78	.43	.33	.26	.20	.15	.11	.06
79	.41	.32	.25	.19	.14	.11	.06
80	.40	.31	.24	.18	.14	.10	.06
81	.39	.30	.23	.17	.13	.10	.05
82	.38	.29	.22	.17	.13	.09	.05
83	.37	.28	.21	.16	.12	.09	.05
84	.36	.27	.21	.15	.11	.08	.05
85	.35	.26	.20	.15	.11	.08	.04
86	.34	.26	.19	.14	.10	.08	.04
87	.33	.25	.18	.14	.10	.07	.04
88	.32	.24	.18	.13	.10	.07	.04
89	.31	.23	.17	.13	.09	.07	.03
90	.30	.23	.17	.12	.09	.06	.03
91	.30	.22	.16	.12	.08	.06	.03
92	.29	.21	.15	.11	.08	.06	.03
93	.28	.21	.15	.11	.08	.05	.03
94	.27	.20	.14	.10	.07	.05	.03
95	.26	.19	.14	.10	.07	.05	.02
96	.26	.19	.13	.09	.07	.05	.02
97	.25	.18	.13	.09	.06	.04	.02
98	.24	.18	.12	.09	.06	.04	.02
99	.24	.17	.12	.08	.06	.04	.02
100	.23	.16	.12	.08	.06	.04	.02

McWANE CAST IRON PIPE COMPANY

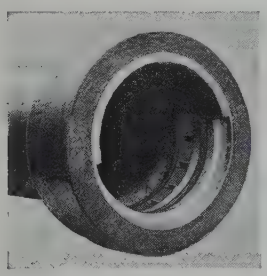
General Offices and Foundries, Birmingham, Ala.

District Sales Offices

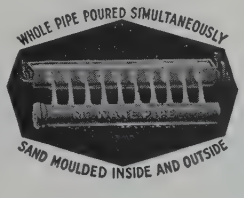
123 South Broad St. Philadelphia
208 So. La Salle St. Chicago
1807 Santa Fe Bldg. Dallas, Texas

Pacific States Cast Iron Pipe Company

Provo, Utah
149 W. 2nd South St. Salt Lake City
111 Sutter St. San Francisco
417 So. Hill St. Los Angeles
267 Washington St. Portland



McWane Cast Iron Pipe.—McWane Cast Iron Pipe is of bell and Spigot type, in standard lengths, sand cast, and manufactured in modern weights. It is distinguished by high transverse as well as tensile strength, and cuts and taps and ships particularly well, being a soft, dense-grained gray iron.



Specifications.—McWane Pipe is made of various weights and dimensions, according to the service and pressures for which it is designed. As Class 150 pressures are commonest used, the following table gives the McWane specifications for pipe for that maximum pressure . Those for pipe for higher pressures furnished on request.

McWane Pipe, Class 150 Specifications and Dimensions

Diameter in Inches			Lengths, in feet	Thickness inches	Weight per foot
Nom.	Int.	Ext.			
1¼	1.25	1.75	5	.25	4
2	2.	2.5	6	.25	6
3	3.031	3.656	6	.312	11
4	4.01	4.63	12	.31	15
6	6.15	6.91	16 and 12	.38	25
8	8.22	9.06	16	.42	37
10	10.21	11.09	16	.44	49
12	12.23	13.19	16	.48	63

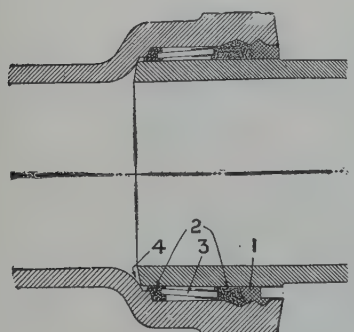


FIGURE 1
Structure of McWane Precalked Joint as Adapted to 1¼, 2, and 3 inch Sizes.
1—Lead. 2—Jute. 3—Iron Wedges.
4—Shoulder of Bell.

The McWane Precalked Joint: As shown in Fig. 1, to the left, this Precalked Joint is factory-made in the bells of McWane Pipe. It is a lead-and-jute joint with a self-tightening feature which prevents leakage under later settlement or movement of the line.

Precalked Joints make it possible to lay Bell and Spigot McWane Pipe without use of lead-pot, or doing any yarning, melting, or pouring on the job. The Joint is **made** in the McWane foundries and merely **finished** in the user's trenches—at "three times the speed for half the cost."

Each Precalked Joint is uniformly and accurately made, carefully inspected, and delivered protected by wooden blocks which preserve it until the pipe is put into service.

Unskilled labor can make tight joints easily and quickly with this Precalked Joint.

Precalked Joint Fittings—exclusive with McWane—contribute largely also to the economy and speed of laying McWane pipe.

Very Small Cast Iron Pipe: The smallest cast iron pipe being made in America is the McWane 1¼-inch size. It, with the McWane 2 and 3 inch, offers water works officials a small diameter pipe at a low cost per foot and lowest cost of all per year. It has all the permanence and desirable qualities of the larger cast iron mains, and makes possible a complete system of one enduring material and proven longevity. The Precalked Joints make it possible to lay McWane small cast iron pipe as rapidly and cheaply as steel pipe.

Intermediate threaded joints, specially reinforced in the McWane types, make it possible also to ship the 2 and 3 inch sizes, in carloads, in 18 foot laying lengths, without resort to welding. Field joints are Precalked lead-and-jute.

Uses of Small Cast Iron Pipe: In addition to the salvage value of using McWane small cast iron pipe wherever perishable pipe is now being used for small-diameter temporary lines, and taking it up to use elsewhere later, it has numerous advantages in the following fields:

Services: A cast iron service is a trouble-free service. Larger capacity, practically endless life, and low cost per foot and per year distinguish it. McWane Bell Braces (see catalog) replace lead goosenecks with it if desired at further savings. Or two meters can be fed through one cast iron service, halving the pipe and trenching cost and making it lower than steel pipe, in cost.

Parallel Mains: In outlying residential blocks and streets, much crossing under costly paving with services can be avoided by running a 2 or 3 inch McWane cast iron main in the parkway down the opposite side of the street from the large fire-protection main. Each side of the street then feeds from its own main, no paving is cut except once to the block for cross-connections, and circulation of water is better. The total cost is less than with one main and numerous longer services crossing the street to each lot.

Golf Courses: Permanent irrigating systems for golf courses, park lawns, cemeteries, etc., are being installed constantly of McWane cast iron pipe. Only McWane makes cast iron pipe small enough to furnish a complete installation in one kind of pipe—from 1¼ inches up through 12 inches. Low cost and freedom from future rust troubles are its advantages for such purposes.

Special Pipe: A number of special types of pipe are also made by this company for use in filter plants, sewage disposal plants, condensers, high pressure gas mains, acid lines, etc. Full details and quotations gladly furnished on receipt of specifications and other details.

Write for McWane catalog.

INDEPENDENT CONCRETE PIPE COMPANY

201 North West St., Indianapolis, Ind.

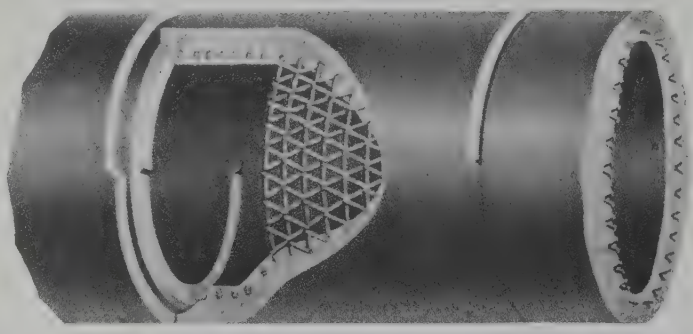
Manufacturers of Reinforced Concrete Pipe

Agencies and Branch Offices in Principal Cities

Products: INDEPENDENT REINFORCED CONCRETE PIPE.

INDEPENDENT CONCRETE PIPE FOR PERMANENCE

The Manufacture of Independent Reinforced Concrete Pipe: The manufacture of Independent Reinforced Concrete Pipe is a simple process. It assures the best quality pipe and, by its very nature, makes inspection and close observation easy during every phase of the work. The reputation of this company has been built on the uniformly excellent quality of its pipe. The company's superintendents, therefore, are men who have a tradition to uphold, and, being responsible for the pipe manufactured on their respective projects, take great pains to produce a high standard of pipe.



Independent Pipe are built to provide recesses to receive the mortar used in sealing the joint. A stiff mortar is trowled into the recess on the inside of the pipe throughout the lower half and into the recess on the outside of the pipe on the upper half of the circumference

Each project is handled as a unit in itself. A trained superintendent is sent into the territory, mixers, tools, forms, and other necessary articles of equipment are shipped to him. Labor, materials, and all other supplies, providing, of course, that they meet the specifications, are obtained locally, so that the manufacture of Independent Reinforced Concrete Pipe becomes a temporary local industry.

The pipe is manufactured either directly along the trench line or in a central pipe yard. In the latter instance, after proper curing, the pipe is delivered along the trench line.

The actual manufacture of Independent Concrete Pipe is in accord with the most highly approved and efficient methods for the manufacture of reinforced concrete pipe under the field method. Building equipment of the finest quality is used. Throughout the entire process the greatest care is exercised to see that each phase of the work is done carefully and satisfactorily thereby insuring a finished product of Independent quality.

To further the care and efficiency of the work on each project, traveling supervisors, coming directly from the home office, visit each project at regular intervals to consult with the superintendent in charge and to make any helpful suggestions or institute any corrective measures that may be needed.

Independent Concrete Pipe can be designed to carry any desired trench load, is easily placed in the ditch, permits immediate backfilling and, due to the smooth internal surface of the pipe, has a carrying capacity excelled by no competitive type of material.

Independent Concrete Pipe is made in sizes from 24 to 108 inches, inclusive. During the operating year 1927, the

The installation of Independent Concrete Pipe at Niles, Illinois, shown above, portrays a difficult delivery, as well as the use of heavy equipment by the contractor. Note that the pipe is laid right up to the point where the trencher is at work

Continued on Next Page

average size of pipe manufactured by this company was 51 inches.

The recessed joint of Independent Concrete Pipe gives it a distinct advantage over other types of sewer construction, and this advantage is especially important when bad ground conditions, such as wet, caving trenches, are encountered. The joint is so constructed that the recess for the sealing of the pipe on the lower half is on the inside, and the recess on the upper half is on the outside, or top. This permits the pipe to be placed in narrow cuts, sometimes only a few inches wider than the pipe itself, and still gives access to the joint for quick sealing. This quick sealing is particularly advantageous in a trench containing water, where frequently the water can be held back for only a short time. Therefore, regardless of trench conditions, Independent Concrete Pipe is quickly and easily laid, with a tight, dependable joint assured, due to the fact that the joint is visible at all times in the sealing.

TABLE SHOWING DETAIL OF STEEL REINFORCEMENT IN STANDARD INDEPENDENT CONCRETE PIPE

Longitudinals Spaced 4 Inches; Cross Wires Number 14 Gauge Spaced 4 Inches
(From American Steel & Wire Company's "Engineer's Handbook.")

Style Number	Number and Gauge of Wires, each Longitudinal American Steel & Wire Company's Steel Wire Gauge	Sectional Area Longitudinals Square Inches Per Foot Width	Total Effective Longitudinal Sectional Area Square Inches Per Food Width	Approximate Weight, lbs. Per 100 Square Feet
068	1—No. 8 gauge	.062	.068	35
080	1— " 7 "	.074	.080	40
093	1— " 6 "	.087	.093	45
107	1— " 5 "	.101	.107	50
126	1— " 4 "	.120	.126	57
146	1— " 3 "	.140	.146	65
153	1— " ¼ inch	.147	.153	68
168	1—No. 2 gauge	.162	.168	74
180	2— " 6 "	.174	.180	78
208	2— " 5 "	.202	.208	89
245	2— " 4 "	.239	.245	103
267	3— " 6 "	.261	.267	111
287	3— " 5½ "	.281	.287	119
309	3— " 5 "	.303	.309	128
336	3— " 4½ "	.330	.336	138
365	3— " 4 "	.359	.365	149
395	3— " 3½ "	.389	.395	160

TABLE OF DIMENSIONS

Size	Wall Thickness	Total Minimum Cross Sectional Area of Circular Reinforcement per Foot Length of Pipe	Number of Rings
24 in.	3 in.	.068 sq. in.	1
27 in.	3 in.	.080 sq. in.	1
30 in.	3½ in.	.093 sq. in.	1
33 in.	3¾ in.	.107 sq. in.	1
36 in.	4 in.	.126 sq. in.	1
39 in.	4¼ in.	.146 sq. in.	1
42 in.	4½ in.	.153 sq. in.	1
45 in.	4½ in.	.153 sq. in.	1
48 in.	5 in.	.219 sq. in.	2
54 in.	5½ in.	.260 sq. in.	2
60 in.	6 in.	.294 sq. in.	2
66 in.	6½ in.	.333 sq. in.	2
72 in.	7 in.	.361 sq. in.	2
78 in.	8 in.	.413 sq. in.	2
84 in.	8 in.	.425 sq. in.	2
90 in.	8 in.	.495 sq. in.	2
96 in.	8½ in.	.581 sq. in.	2
102 in.	8½ in.	.610 sq. in.	2
108 in.	9 in.	.682 sq. in.	2

Sizes up to and including 72-inch are manufactured in 4-foot lengths, and above 72-inch, in 5-foot lengths.

QUANTITIES OF MATERIAL FOR ONE CUBIC YARD OF CONCRETE IN PLACE

(From Taylor & Thompson's "Concrete, Plain and Reinforced.")

Proportions by Parts			Percentages of Voids in Broken Stone or Gravel								
			50%			45%			40%		
Cement	Sand	Stone	Bbls. Cement	Yds. Sand	Yds. Stone	Bbls. Cement	Yds. Sand	Yds. Stone	Bbls. Cement	Yds. Sand	Yds. Stone
1	1½	2	2.39	0.53	0.71	2.30	0.51	0.68	2.22	0.49	0.66
1	1½	3	2.01	0.45	0.89	1.91	0.42	0.85	1.83	0.41	0.81
1	2	3	1.81	0.54	0.80	1.74	0.52	0.77	1.67	0.50	0.74
1	2	3½	1.69	0.50	0.88	1.61	0.48	0.83	1.54	0.46	0.80
1	2	4	1.58	0.47	0.94	1.51	0.45	0.89	1.44	0.43	0.85
1	2	4½	1.49	0.44	0.99	1.41	0.42	0.94	1.34	0.40	0.89
1	2	5	1.40	0.42	1.04	1.33	0.39	0.98	1.26	0.37	0.93
1	2½	3	1.65	0.61	0.73	1.59	0.59	0.71	1.53	0.57	0.68
1	2½	3½	1.55	0.57	0.80	1.48	0.55	0.77	1.42	0.52	0.74
1	2½	4	1.46	0.54	0.87	1.39	0.51	0.82	1.33	0.49	0.79
1	2½	4½	1.38	0.51	0.92	1.31	0.48	0.87	1.25	0.46	0.83
1	2½	5	1.31	0.48	0.97	1.24	0.46	0.92	1.18	0.44	0.87
1	2½	6	1.18	0.44	1.05	1.12	0.41	1.00	1.06	0.39	0.94
1	3	4	1.35	0.60	0.80	1.30	0.58	0.77	1.25	0.56	0.74
1	3	5	1.22	0.54	0.90	1.16	0.52	0.86	1.11	0.49	0.82
1	3	6	1.11	0.49	0.99	1.06	0.47	0.94	1.01	0.45	0.90
1	3	7	1.02	0.45	1.06	0.97	0.43	1.01	0.92	0.41	0.95
1	4	6	0.99	0.59	0.88	0.95	0.56	0.84	0.91	0.54	0.81
1	4	7	0.92	0.54	0.95	0.88	0.52	0.91	0.83	0.49	0.86
1	4	8	0.86	0.51	1.02	0.81	0.48	0.96	0.77	0.46	0.91

Use 50% columns for broken stone screened to uniform size. Use 45% columns for average conditions and for stone with dust screened out. Use 40% columns for gravel or mixed stone and gravel.

View of a splendid line of 84-inch Independent pipe laid in shale rock at Clawson, Michigan. Notice how smoothly the pipe is laid in the curves

UNITED STATES CAST IRON PIPE & FOUNDRY COMPANY

General Office: Burlington, N. J.

Manufacturers of Cast Iron Pipe—Bell and Spigot, Flange, Flexible Joint, High Pressure, Plain End and Threaded Fittings—Cast Iron Bell and Spigot or Flanged—Standard and Special Castings—Municipal or Hydraulic—Standard or to Engineers' Designs

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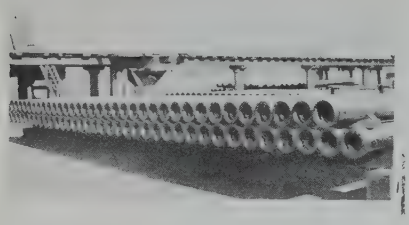


deLavaud Centrifugally Cast Cast-Iron Pipe: Cast Iron Pipe is inherently so satisfactory for underground work that it has been claimed that much improvement was impossible. However, by the utilization of centrifugal force in the manufacture of pipe a method has been developed that produces pipe superior in many respects to that cast in sand molds.

The method used by our company in making centrifugally cast pipe was invented by D. S. deLavaud, a Brazilian engineer, and was perfected commercially by our company. A metal mold is rotated horizontally and at the same time the molten metal is fed into the mold at a uniform rate of flow so that the rotary force throws the metal against the mold forming the pipe. This eliminates the use of all cores except the small core for forming the inside of the bell. The centrifugal force acting on the molten iron forces from the metal all impurities and gives it a very homogeneous structure.

A comparison of the specifications for the two materials show that the metal from pipe cast in sand is required to withstand 20,000 lb. per square inch, as compared to 30,000 lb. per square inch for centrifugally cast metal. Actual tests show, however, that the deLavaud pipe will withstand a much greater load than the 30,000 lb. per square inch required.

Qualities of deLavaud Pipe: deLavaud pipe has an even greater resistance to corrosion than sand cast pipe.
It is cheaper to install, owing to its uniform lead space and self centering bell.

It is easy to cut and tap.

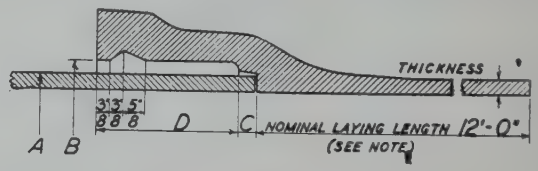
Its greater strength and uniform sections make it valuable for use for higher pressures.

It lends itself particularly well to the use of sleeve joints, due to its smooth exterior and uniform circumference.

deLavaud pipe is made to be used with standard fittings and specials.

As the outside diameters of deLavaud pipe are the same as for sand cast pipe the reduction in thickness results in a larger inside diameter and increased carrying capacity which is further increased by the unusually smooth interior surface of deLavaud pipe.

The method of manufacture of deLavaud cast iron pipe and the product itself have been approved by the Underwriters' Laboratories of the National Board of Fire Underwriters.



Dimensions and Weights of Standard Bell and Spigot deLavaud Pipe

Nominal Diameter Inches	Class or Maximum Working Pressure	Average Thickness	Weight of Pipe Pounds	Weight Per Foot Including Bell
4	50	.30	175	14.6
4	150	.34	200	16.6
4	250	.37	215	17.9
6	50	.32	280	23.3
6	150	.36	310	25.8
6	250	.40	340	28.3
8	50	.36	410	34.2
8	150	.38	435	36.3
8	200	.42	475	39.6
8	250	.46	515	42.9
10	50	.39	540	45.0
10	150	.42	585	48.7
10	200	.48	657	54.7
10	250	.52	705	58.7
12	50	.42	700	58.3
12	150	.46	765	63.7
12	200	.52	850	70.8
12	250	.58	935	77.9
14	50	.44	848	70.7
14	100	.50	931	77.6
14	150	.55	1065	88.7
14	200	.62	1186	98.8
16	50	.45	1000	83.3
16	100	.52	1135	94.6
16	150	.60	1325	110.4
16	200	.66	1442	120.1
18	50	.48	1190	99.2
18	100	.56	1367	113.7
18	150	.64	1579	131.6
18	200	.71	1740	145.0
20	50	.50	1381	115.0
20	100	.59	1599	133.2
20	150	.69	1904	158.7
20	200	.76	2074	172.8

The nominal laying length is given as 12'0" but the actual laying length of full length pipe shown in the table above is 12'1".

Gas Pipe—for average gas installations we recommend Class 150 in diameters 4" to 12" inclusive and Class 100 pipe in diameters 14" to 20" inclusive.

Class 50 pipe are recommended for flow lines, drains, exhaust lines and other low pressure installations where frequent tapping is not required. All weights are approximate and are based on the nominal laying length of 12'0".

Pipe of heavier wall thickness than shown in the above table can be furnished if desired.

Continued on Next Page

Weights of Standard Bell and Spigot deLavaud Pipe 18′0″ Nominal Laying Length

Table II

Nominal Diameter, Inches	Class or Maximum Working Pressure	Weight of Pipe Pounds	Weight per Foot Including Bell
4	50	254	14.1
4	150	289	16.0
4	250	311	17.3
6	50	404	22.4
6	150	448	25.0
6	250	493	27.4
8	50	594	33.0
8	150	629	35.0
8	200	688	38.2
8	250	747	41.5
10	50	795	44.2
10	150	849	47.2
10	200	957	53.2
10	250	1028	57.1
12	50	1015	56.4
12	150	1109	61.6
12	200	1238	68.8
12	250	1365	75.8

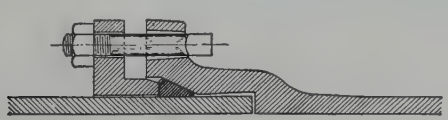
NOTE: Thickness same as in 12 ft. Pipe.

Bell and Plain End Joints: Our deLavaud pipe is regularly equipped with bell and plain end joints similar to the Metropolitan Type of bell. In laying it is only necessary to place the end of one pipe in the bell of the next and slide it forward until it rides upon the taper and automatically centers itself.

Once in place and calked in the usual manner these joints show unusual resistance to blowing out. In a recent test 6-in. joints calked with lead withstood an average of 666 lb. per square inch pressure when the pipe were not restrained against longitudinal motion.

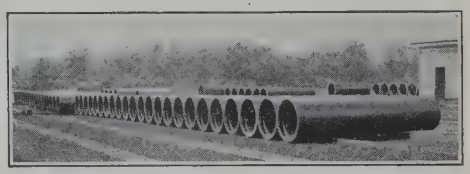
In spite of their strength these joints are very flexible. A joint of this nature after calking was recently deflected until the sections of pipe were at an angle of 12° 56′ before failure. The equivalent radius of curvature for this deflection is about 82 ft. These tests show that the new bell and plain end has all the advantages of the bell and spigot type.

All things considered it is evident that deLavaud centrifugally cast cast-iron pipe is an ideal material for many installations and we believe it is only a question of time before this material will revolutionize the use of pipe in industry.



The Anthony High Pressure Joint: deLavaud centrifugally cast pipe also comes equipped with the Anthony Joint. This joint remains absolutely tight under maximum pressures used for supply or distribution lines and provides for an unusual amount of flexibility.

If desired, deLavaud Pipe can be shipped in 24 ft. lengths with a welded joint in the center of each length. Such an installation as this requires only 220 gaskets to the mile—only one quarter of the usual number.



U. S. Cast Iron Pipe and Fittings: Cast Iron Pipe with bell and spigot joints has long been the standard for water supply and distribution lines. The flexibility of this type of installation makes it ideal under the exacting conditions of this service. All types of fittings are available for use with this pipe. For high pressure service bell and spigot pipe and fittings are equipped with lugs for bolting the joints together.

Castings: Our facilities for handling municipal and hydraulic castings are exceptional. These castings vary in size from 1 lb. to 50 tons and can be finished in accordance with our standards or to your engineer's designs.

Numerous foundries advantageously located make it possible for us to offer unusual service both in manufacture and shipment.

Flanged Pipe: In recent years, the tightness and strength of the flanged joint have become of value for many special purposes. Flanged pipe is very generally used in power stations and similar buildings, where pipe lines are well supported. The dimensions of flanges, drilling, etc., adopted as standard for all flanged pipe except that for gas, are those recently adopted by the Committee of Manufacturers and the American Society of Mechanical Engineers, and known as the "American Standard."

Handbook of Cast Iron Pipe for All Services: A handbook has recently been issued by the Cast Iron Pipe Research Association covering good engineering practice in laying Cast Iron Pipe. This book also contains chapters on the usual problems confronting users of this material. We shall be glad to send a copy to any Engineer interested in piping. Write us for "Handbook of Cast Iron Pipe."

R. D. WOOD & COMPANY

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We Still Manufacture "Sand Cast" Pipe Now Known As "Pit-Cast" Pipe.

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Continued on Next Page

Mathews Fire Hydrants (Reg. U. S. Pat. Off.) are of particularly substantial, simple construction, and of great economy and flexibility. They are correctly designed to a fundamentally sound principle and meet the most exacting demands of modern water works practice.

The entire barrel, which contains all the working parts including the VALVE SEATS, is removable through the sliding protection case without digging up or disturbing the ground. This brings practically the entire hydrant above ground where the working parts are visible and accessible. Repair work on the ground, particularly in cold or bad weather, is unnecessary. A spare barrel may be kept on hand to quickly replace the one requiring attention.

Because of this feature, **Mathews Hydrants** which may be broken by automobiles, can be quickly replaced without the usual expense of excavating or breaking the pavement.

It is also possible to change both the number and the direction of the nozzles without excavating or disturbing the ground.

Change of Grade—There are several methods of raising the nozzle level of Mathews Hydrants. The methods used depends largely on local conditions.

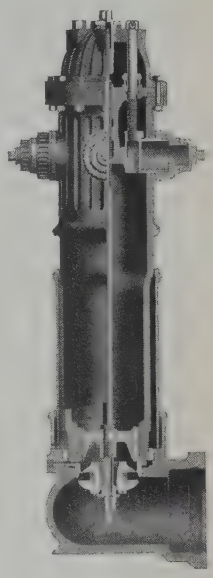
We can furnish an easily installed extension piece which is placed between the elbow and the barrel or standpipe. Another method is to replace the entire barrel and protection case with new ones of proper length—either longer or shorter as the case may be.

Both the above methods require but a small amount of excavation.

A Mathews Hydrant may also be raised **without excavating**, by removing the barrel, placing an inexpensive extension section on top of the casing and inserting a new barrel of proper length.

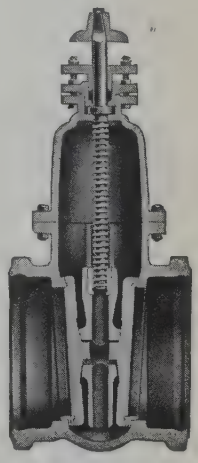
The old barrel may be used on future extensions where the grade is normal.

Mathews' High Pressure Fire Hydrants: Designed along the lines of our Standard Mathews Hydrant, amply strong in all its parts to withstand the severe service for which it is intended. This Hydrant in actual service, has proven itself thoroughly reliable under the high pressure specified by Fire Engineers throughout the country. With this type of hydrant the valve which controls the water is most important—it must be reliable and easy to operate under extremely high working pressure. This has been accomplished by means of a simple but effective relief valve within the main valve, which opens with the first few turns of the wrench, permitting the water to enter the body of the hydrant, equalizing the pressure on the main valve.



A few cities which are being successfully served by Mathews High Pressure Fire Hydrants are—Atlantic City N. J.; Buffalo, N. Y.; Cleveland, Ohio; Toledo, Ohio; Winnipeg, Canada.

"Wood" Gate Valves are designed to A. W. W. A. specifications. They are exceptionally heavy weight—fully bronze mounted and tested to three hundred pounds pressure.



The features making these valves unusually suited for severe underground service are:

Taper Seats—which insure tightness and easy operation.

Independent Revolving Discs—free to revolve and find a new seat each time the valve is operated, preventing unequal wear and leakage.

One Piece Spreader—Simply, but properly designed, easy acting without secondary motion.

Unexcelled Simplicity—Only four internal parts—stem, spreader and two discs. No corners or pockets to accumulate sediment and scale.

R. D. Wood & Company are also prepared to quote on Foot Valves, Check Valves and Cast Iron Extension Valve Boxes, Hydraulically and Electrically Operated Gate Valves, Light Pressure Gate Valves, Intake Screens, Fish Traps, and miscellaneous Water Works Castings.

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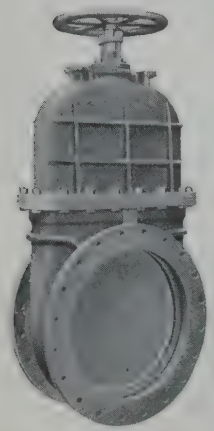
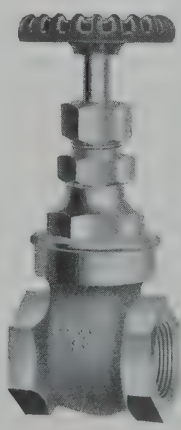
CRANE

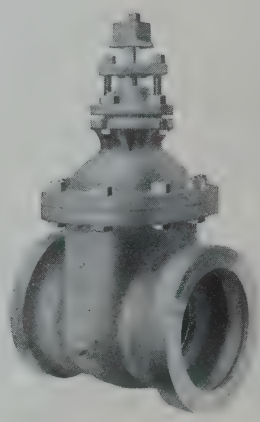
The products shown on these two pages only hint at the wide range and extent of the Crane Co. line. More detailed information, specifications, and dimensions of any of the products shown, as well as similar data on all materials made by Crane Co. for water works use, may promptly be secured by addressing the nearest one of the branches listed above. Or a letter to the General Office at 836 S. Michigan Ave., mentioning the piping materials in which you are interested, will bring comprehensive descriptive literature.



No. 791 Double Disc Gate Valve



No. 438 Wedge Gate Valve

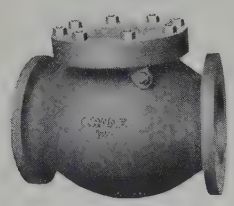


No. 480½ Double Disc Gate Valve

No. 791 Double Disc Gate Valve: Low pressure, non-rising stem, with iron body, brass trimmings, and brass stem. For water working pressures up to 30 pounds. Made in sizes from 14 to 72 inches, supplied with and without gear.

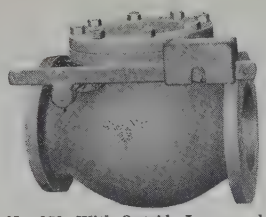
No. 438 Wedge Gate Valve: Brass, non-rising stem, with a gland in the stuffing box. A standard, general service valve, in sizes from ¼-inch to 3-inch, for steam working pressures up to 125 pounds. When wide open, these valves may be repacked while under pressure.

No. 480½ Double Disc Gate Valve: Specifically designed to meet the specifications of the American Water Works Association. Iron body, parallel seats, non-rising stem, hub ends. The discs always ride down to a tight, true position even under the most severe operating conditions. For water working pressures up to 175 pounds. Tested to 300 pounds hydraulic pressure.



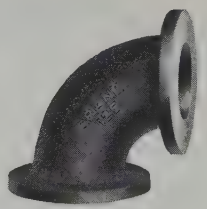
No. 373 Swing Check Valve

No. 373 Swing Check Valve: Iron body, brass seat, with brass or leather faced disc. Can be used in horizontal position or for upward flow. In sizes from 2-inch to 30-inch. 16-inch and smaller for steam working pressures up to 125 pounds; above 16-inch, 100 pounds. Water working pressures ratings are 40% higher up to 12-inch, and 20% higher for 14-inch and larger sizes. To order, this valve can be supplied with by-pass.



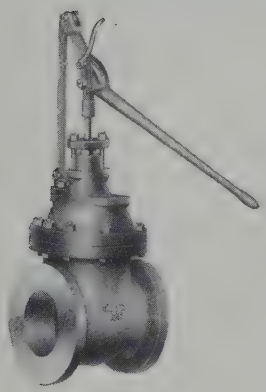
No. 373, With Outside Lever and Weight

No. 373, With Outside Lever and Weight: This check valve is especially adapted to service in connection with centrifugal pumps. The lever and weight feature seats the disc upon the slightest backflow, thereby eliminating the shock which results with ordinary check valves.



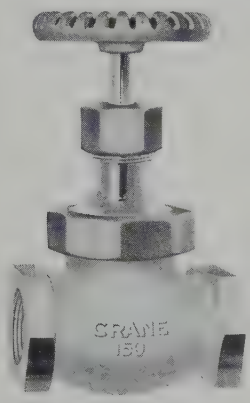
No. 525 Standard Flanger Elbow

No. 525 Standard Flanged Elbow: Of cast iron, for steam working pressures up to 125 pounds, or water working pressures 40% higher in 12-inch and smaller size, and 20% higher in 14-inch and larger. Supplied faced or faced and drilled, in sizes from 1¼-inch to 24-inch.



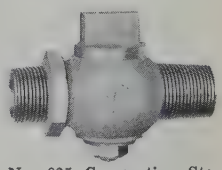
No. 471 Wedge Gate Valve

No. 471, Wedge Gate Valve: Iron body, brass trimmings, with a quick-opening sliding stem. Supplied with flanged or screwed ends. In sizes from 2-inch to 16-inch. For steam working pressures up to 125 pounds; water working pressures 175 pounds for sizes 12-inch and smaller, 150 pounds for 14 and 16-inch.



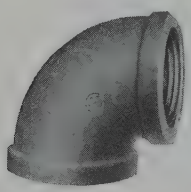
No. 7 Many Purpose Globe Valve

No. 7 Many Purpose Globe Valve: A screwed end general utility valve of brass with renewable disc; wheels, stuffing box nuts, and union bonnet rings of malleable iron to give strength where wear is hardest. When leaks occur, new disc can be quickly inserted, and the valve—when wide open—can be repacked while under pressure. In sizes from ⅛-inch to 3-inch, for steam working pressures up to 150 pounds, and proportionately higher water working pressures.



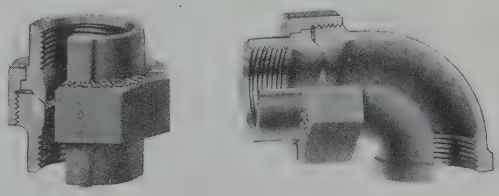
No. 835 Corporation Stop Cock

No. 835 Corporation Stop Cock: Of brass, with coarse thread for wood pipe mains. In four sizes from ½-inch to 1-inch.



Standard Brass Steam Elbow

Standard Brass Steam Elbow: Of high quality brass. For use where service conditions dictate the use of this metal, as well as installations in which brass pipe is preferred or specified.



Unions and Union Fittings

Unions and Union Fittings: No. 519 union and No. 590 union elbow, both with female ends, are representative of a complete line, of malleable iron, with leakproof brass to iron seats, eliminating gaskets and readily taken apart. Tested to 250 pounds hydraulic pressure.

AMERICAN MANGANESE BRONZE COMPANY

Main Office and Works: Holmesburg, Philadelphia, Pa.

Metallurgical Engineers and Founders

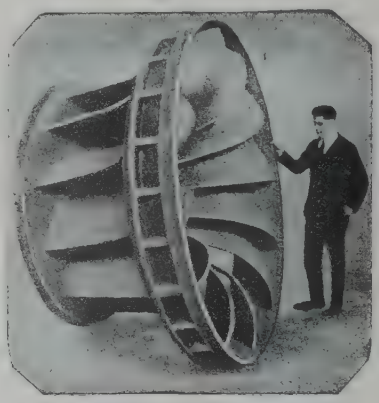
Cleveland: 508 Leader Bldg. Milwaukee: 428 Wisconsin Ave. Pittsburgh: 205 Oliver Bldg. Wyoming, Pa. New York: 225 Broadway

Products: Turbine Runners, Large Valves and Stems (forged or cast), Valve Operating Parts, Sluice Gate Roller Bearings and Slides, Shaft Caps, Screwed and Flanged Pipe Fittings, Expansion Joints, Large Needle Point Valves.

We have had **more than 20 years experience** in producing high grade bronze products for Hydraulic installations, such as: Catskill Aqueduct, Arrow Rock Dam, Niagara Falls (Canadian and American), Hetch Hetchy, Southern California Edison, Los Angeles Light and Power, Elephant Butte Dam, New York State Barge Canal, Carolina Light and Power Company, Norwood Development, etc.

Our Foundry is one of the largest and best equipped exclusive Bronze Foundries in the United States, and is located on the Main Line of the Penna. R. R. within the limits of Philadelphia. Complete Chemical and Physical Testing Laboratories as well as adequate machining facilities are available.

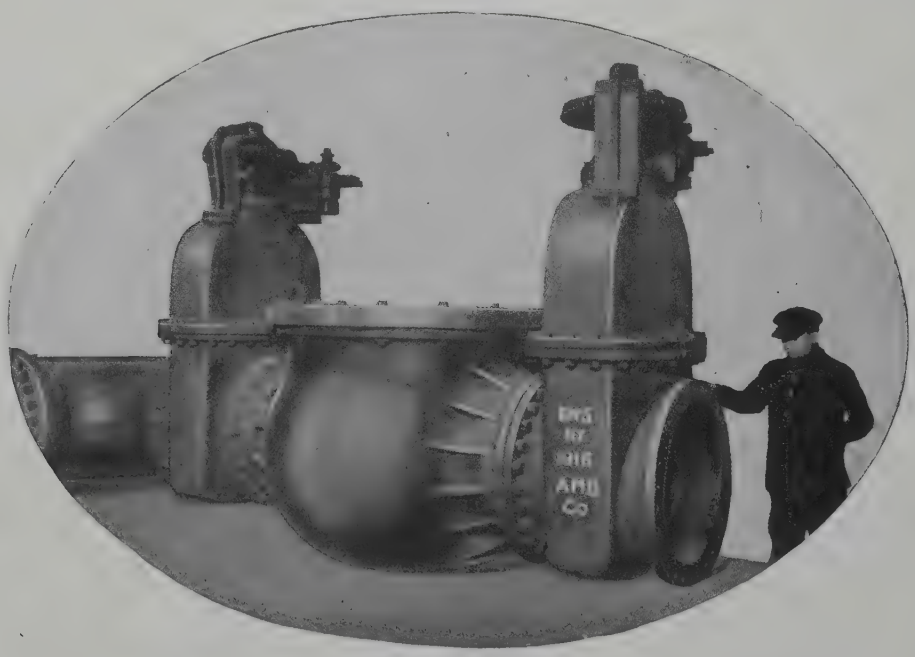
We will furnish upon request our Valve Stem catalog and also our literature on Hy-ten-sl Bronze, **The Strongest of Bronzes.**



One of the Many Bronze Turbine Runners Made by Us—Weight 16,500 Lbs.

The 3 Principal A. M. B. Co. Metals used are:

1. HY-TEN-SL BRONZE
   (Nos. 1 to 4)
   85,000 to 120,000 lbs. T. S.
2. S. M. B. MANG BRONZE
   75,000 lbs. T. S.
3. TURBINE RUNNER BRONZE
   (Erosion Resisting)
   80,000 lbs. T. S.



A. M. B. Bronze Shaft Cap with 30 Hydraulic Bronze Gate Valves and Flanged Fittings Supplied New York Board of Water Supply for Catskill Aqueduct

GOLDEN-ANDERSON VALVE SPECIALTY COMPANY

1386 Fulton Building, Pittsburgh, Pa.

Automatic Cushioned Controlling Altitude Valves

No metal-to-metal seats, no water hammer.

Products: GOLDEN-ANDERSON AUTOMATIC CUSHIONED CONTROLLING ALTITUDE VALVES.

"Always Cushioned in Closing and Opening."

1. They keep the water level constant in reservoirs, standpipes, tanks, etc., under all conditions.
2. Very simple in design. Contain no floats or fixtures inside or outside the tanks.
3. A perfect cushion by water and air absolutely prevents water hammer, surges and broken mains. No metal-to-metal seats.
4. Can be closed in three ways: by hand, automatically by water if a pipe breaks, and by electricity from distant points.
5. When desired, can be connected to work "both ways" on a single pipe line.

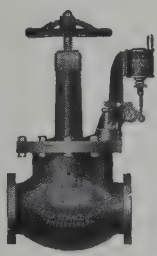
"Made with Stop-Starter Attachments for Centrifugal Pumps."

All the annoyances of freezing are eliminated.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe. *"No valves or fixtures inside." "No fixtures outside of tanks."* Sizes to 24 inches.

Hosts of references. "Every valve with an absolute guarantee."

"Heaviest Valves Made"

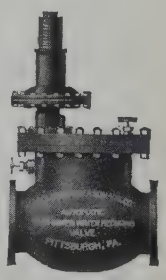


Golden-Anderson Pat. Cushioned Electric Water Service Valves.

1. Give instant control of water distribution from pumping station in case of fire.
2. Open or close by electricity from distant point—a.c. or d.c. circuits. Also close by hand.
3. No waste of electricity. Current is on only few seconds.
4. Cushioned in opening and closing.
5. No water hammer, shock, sticking, surging or chattering.

Golden-Anderson Pat. Automatic Cushioned Water Pressure Regulating Valves.

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required —No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

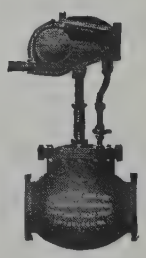


Golden-Anderson Pat. Automatic Cushioned Water Float Valves.

1. Automatically maintain uniform water levels in tanks standpipes, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—Most satisfactory float valves known.
4. No metal-to-metal seats — No water hammer or shock.
5. Cushioned by water and air. sizes ½ to 24 in.

Golden-Anderson Patented Automatic Cushioned Controlling Float Valve.

1. Automatically maintains uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle and Globe patterns to 24 in.



Golden-Anderson Pat. Cushioned Water Relief Valves.

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and Globe patterns. Sizes 3 to 24 in.

Golden-Anderson Pat. Automatic Double Cushioned Check Valves.

1. Especially adapted for water service.
2. For high or low pressure.
3. Thoroughly cushioned. No chattering hammering or sticking.
4. Globe or Angle patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.

Cushioning is of vital importance.

Safety demands perfect cushioning.

Water Taps by Whom Made and Costs

The following interesting information on the installation of water taps and connections in the state of New York is taken from *Water Works*. A questionnaire was sent to various municipalities and from their replies the report was compiled.

Who Pays for the Water Tap?—Fifty-eight municipalities reported that the consumer paid for the water tap and connections in their cities. Five cities reported that the consumer did not pay these costs.

Albion reports that connections on mains only were made by the village, all other costs being paid by the consumer. At Cortland the property owner pays for the water tap and connections. Cohoes reported that the consumer pays for corporation cocks and tapping main, and that the consumer does the excavating and backfilling. At Illion the consumer pays for the water tap and connections and also the cost of making cuts in the street and repairing them. At Medina the consumer pays for the cost from residence to curb, while at North Tonawanda he pays for the tap only. At Ogdensburg the consumer pays the costs for installation from outer edge of sidewalk to house only. At Sherrill the consumer pays the largest part of the cost, while at Tarrytown he pays for tap only. At Seneca Falls the company brings the service as far as the curb, and the consumer pays for the balance of the work. At Saranac Lake the village furnishes the tap and the consumer pays for corporation and curb cocks.

Who Does This Work?—Thirty-two cities reported that the municipality did the work of installing water taps and connections, while 12 cities reported that they didn't do this work. Albion makes the tap, while Auburn makes the installation as far as the curb. Amsterdam does the work only when connections are in excess of 1 in.; smaller taps are done by plumbers. Binghamton does the work from main to curb, while Batavia makes the taps, the connections being made by the property owner under supervision of the city. Cortland makes only large taps for fire protection. Fulton and Gloversville do only the work to the curb. Ithaca taps main only. Kenmore, Little Falls, Middletown, Mount Vernon, Newburgh, Rochester, Sherrill, Tonawanda and Waverly make the tap only. At Olean the city lets contract to lowest bidder and work is done under city inspector. Scotia makes the tap and furnishes the connections only. At Schenectady the city makes taps. Plumber gives 24 hours notice when trench will be opened in readiness for making tap. Plumber furnishes all material except corporation cock, curb cock and cock box. These are included in the charge for the tap. At Saranac Lake the municipality furnishes the labor and the consumer pays for the brass connections. Walden makes tap free of charge, but property owner does all excavation and pays for all material furnished. At Mechanicsville the work is done by the municipality. Any licensed plumber may do the work under the instructions of the commissioner of public works.

Charges for Making Taps and Connections.—The replies to the question, "If the municipality does the work, what charge or charges does it make for making such water tap and connection?" are summarized as follows in the report:

Albion—No charge for making tap.

Auburn—Actual cost of work.

Amsterdam—Actual cost. For excavation on dirt street a deposit of $10, practically all rebate; for excavation of good macadam a deposit of $20 cost charge; for excavation of brick and concrete a deposit of $5 for lineal foot, charges deducted from deposit.

Binghamton—For ¾ in. tap, $22, and for 1 in. tap, $30. $10 extra for pavement cut.

Batavia—For ¾ in. tap, $3; for 1 in. tap, $3.50. All excavating and laying of service pipe done by and at expense of owner.

Beacon—½ in. tap, $2.50; ¾ in., $3.00. Extra or additional taps, $1.50; sewer taps, $1.50.

Buffalo—Bureau of Water installs all taps and makes all branch connections. Plumber is required to make application and payment for any taps required. In case of a connection larger than 3 in. he must make a deposit of a certain amount. After city's work is done it either bills him for the difference or refunds any excess amount paid. All excavating must be done by plumber or contractor. Following are the charges for taps and deposits for connections:

⅝ in., $4; ¾ in., $5; 1 in., $7; 1½ in., $10; 2 in., $15.

Deposits:

4 in. x 4 in.	$ 70	10 in. x 8 in.	$140
6 in. x 4 in.	95	12 in. x 8 in.	160
8 in. x 4 in.	100	16 in. x 8 in.	185
10 in. x 4 in.	110	20 in. x 8 in.	205
12 in. x 4 in.	130	10 in. x 10 in.	165
16 in. x 4 in.	155	12 in. x 10 in.	185
20 in. x 4 in.	165	16 in. x 10 in.	205
6 in. x 6 in.	105	20 in. x 10 in.	225
8 in. x 6 in.	110	12 in. x 12 in.	215
10 in. x 6 in.	125	16 in. x 12 in.	220
12 in. x 6 in.	145	20 in. x 12 in.	240
16 in. x 6 in.	170	20 in. x 16 in.	330
20 in. x 6 in.	180		

Cortland—Time and material costs 20 per cent.

Corning—

	Cost of taps to curb
⅝ in.	$20.50
¾ in.	27.00 Manifold
1 in.	24.00
1 in.	32.00 Manifold
1½ in.	44.00
2 in. tap from 4 in. main	$ 46.00
2 in. tap from 6 in. main	52.00
3 in. tap from 4 in. main	54.00
3 in. tap from 6 in. main	58.00
4 in. tap from 4 in. main	60.00
4 in. tap from 6 in. main	66.00
6 in. tap from 6 in. main	84.00
2 in. tap from 8 in. main	56.00
4 in. tap from 8 in. main	70.00
3 in. tap from 8 in. main	62.00
6 in. tap from 8 in. main	110.00

Cohoes—$5 for ¾ in. and $8 for 1 in. cock and tap.

Catskill—Labor and material.

Canandaigua—$5.

Elmira—A ¾ in. tap and service line from main to cellar costs the consumer $28 as a minimum charge for everything up to 40 ft. All distance over 40 ft. is paid for at the rate of $0.50 per foot. Pipe is laid 5½ ft. deep. All other sizes of service are put in at cost, from main to cellar. When streets are about to be paved we lay ¾ in. AAA lead pipe to the curb for every vacant lot. If for any reason a pavement has to be disturbed to make a connection the consumer pays the pavement repairs as a part of the charge for the service. The charge for service from main to curb is in lieu of frontage tax.

Fulton—A deposit of $15 is required before making tap. Actual cost of corporation, pipe, goose neck, curb stop and box are charged to consumer plus labor of putting same in. City does not dig or back fill trench. Difference between deposit of $15 and actual cost is refunded to consumer.

Floral Park—It is necessary in the village to obtain a street permit. This must be taken out by a bonded plumber. Cost of the permit is $2.50 and the amount of $25 must be deposited. After street is put back in shape and after an inspection $10 is returned to the applicant and the other $15 retained by the village towards repairing such cuts in street.

Freeport—½ in. tap $7.50; 1 in. tap $10; two ½ in. taps, one excavation, $10; two 1 in. taps, one excavation, $15. This has nothing to do with street opening. Plumbers are bonded to replace streets, and this applies to all classes.

Geneva—½ in. tap $5.75; ¾ in. tap $7.50; 1 in. tap and up $12; 1½ in. $16; 6 in. $161.52 plus. City furnishes all materials and labor. 6 in. tap costs between $100 and $150.

Gloversville—Cost.

Hempstead—½ in. tap $5.50; saddle $7.14; ¾ in. tap $7; 4⅝ in. tap $6; 1 in. tap $10.

Hudson—City makes and furnishes tap for $6.

Ithaca—½ in. tap $2.60; ¾ in. tap $2.75; 1 in. tap $3.

Jamestown—City makes no charge for tapping the main and bringing the service to the curb cock located at sidewalk line. This is furnished and installed by the municipality. Property owner carries the service into the building from the curb cock at his own expense.

Johnstown—When a permit is granted for water the city furnishes the service pipe, the curb cock and the corporation cock, does all the work including excavation, back fill-

ing and repaving and furnishes all material up to and including the curb cock box for the following charges: In unpaved streets, ½ in. tap, $18; ¾ in. tap, $21. In streets paved with cobble, macadam or bituminous macadam, ½ in. tap, $30; ¾ in. tap, $34. In streets paved with concrete or any pavement with a concrete foundation, ½ in. tap, $36; ¾ in. tap, $40.

Kenmore—If main is in the center of street, $5. If mains are on the side of street, $45. Note—The village lays on some streets, in fact on all new streets, mains on each side of street, and this $45 reimburses in part the cost of such additional expense, and agreed by all to the best for all concerned, doing away with the necessity of ripping up pavements for repairs.

If street is to be paved, all water mains are run in to the curb, and a charge of $29 is made, where sewer and water is laid in one trench, a charge of $5 is made.

Kingston—In order to insure the best material this department furnishes the tapping outfit to the licensed plumber for which he pays the sum of $10. This includes one ½ in. corporation cock and bend; one ¾ in. curb cock; one ¾ in. solder nipple; one No. 2 service box (curb). This department does the tapping, which is included in the above amount—we require ¾ in. AAA lead to be laid from the main to the curb line—this is also furnished by the consumer, also digging up and replacing pavement.

Long Beach—This is according to size and location under ordinary conditions the prices are as follows: ¾ in., $35; 1 in., $45; 1½ in., $65; 2 in., $75. Plus resurface charge on road openings. $1 per yard on brick roads; $3.50 per yard on asphalt and concrete.

Little Falls—½ in., $2.75; 1 in., $3.20, includes corporation cock, 2 in.-4 in., $18; 6 in., $22; 8 in., $26; 10 in., $30, does not include valve. The owner does excavation and replaces pavement at cost.

Lancaster—$1.

Mechanicsville—Property owner pays the plumber for all work after our inspection if satisfactory.

Mount Vernon—The tapping fees are as follows: ⅝ in., $8.10; ¾ in., $9.85; 1 in., $12.10. For this fee, the water department makes the tap on the main and inserts the corporation cock, and furnishes to the water consumer's plumber the quarter bend for wiping on to the lead service pipe, and the curb cock and the curb box. All excavations for the service line are made by the consumer's plumber.

Medina—All water service is made to curb by water company. From curb to residence by consumer.

Mamaroneck—None other than usual street opening permit charges. Mineola—$9 for each tap; $3 for each street opening.

Middletown—No charge.

Newark—Cost plus 10 per cent.

New Rochelle—Taps and service connection. When application is made for water the applicant shall report to the water company the name of a licensed plumber engaged to do his work. In case of each applicant the company reserves the right to name the size of tap to be inserted in the main. The service pipe from the main to the point where it enters private property will be furnished and owned by the water company, but the laying of the same and the balance of the service pipe, including all fixtures except the meter, shall be done to the satisfaction of the water company. All service pipes to be AA lead. The charge of tapping mains, and furnishing the necessary stop cocks, stop and waste cocks, and check valves which are essential to the safety and convenience of the consumer, will be as follows: ½ in., $10; ⅝ in., $12; 1 in., $18; 1¼ in., $21; 1½ in., $25; 2 in. or larger, $25. ⅝ in. AA lead service pipe to be connected to all ½ in. taps. ¾ in. AA lead service pipe to be connected to all ⅝ in. taps.

Niagara Falls—¾ in. connection, $2.50; 1 in. connection, $3. Consumer pays plumber to bring connection into property from tap on main. Larger size connections are made with sleeves and valves and the cost varies in accordance with amount of labor, etc.

Newburgh—The service pipe from main to the house is laid by the plumber. The curb faucet and curb box being furnished at cost ($8.75) by this department. A charge of $2.25 is made for furnishing corporation faucet and making the tap.

Norwich—We go to curb line only, remainder of pipe to cellar is at expense of property owner.

North Tonawanda—This is for the corporation only. Cocks only, the plumber puts in the service connections.

Oswego—$20 for ⅝ in. lead service; from main to curb in dirt streets, plumber has charge from curb to house. $30 when under paved streets.

Olean—As all work is done by contract prices vary.

Ogdensburg—In case of new service city puts in ¾ in. tap and pipe as far as sidewalk. Consumer stands expense from sidewalk to house. In case of renewal consumer stands expense of main to house, city standing expense of tap and connection at main and curb cock. Over ¾ in. consumer stands extra expense main to house in both new services and renewals. Our paved streets have services laid to vacant lots. Where we break pavements for fire service, etc., consumer stands expense. ¾ in. pipe and trenching ordinary macadam streets per foot, $0.95; 1 in. pipe and trenching, $1; 1¼ in. pipe and trenching, $1.05; 1½ in. pipe and trenching, $1.10; 2 in. pipe and trenching, $1.15.

Penn Yan—$1 for tap and property owner pay all other expenses.

Port Chester—Brick paving, 60 ct. sq. ft.; concrete paving, 60 ct. sq. ft.; wood paving, 60 ct. sq. ft.; macadam, 40 ct. sq. ft.; dirt road, $5; asphalt block, 60 ct. sq. ft.

Port Jervis—This is a privately owned plant. Consumers are obliged to pay for all water taps and service connection. The total charge varies according to the size of service desired by the applicant and the width of the street in which it is installed. Our rates are as follows, for ½ in. AA lead service:

1—½ in. corporation cock and tapping	$4.50
1—½ in. curb cock, curb box and rod	6.50
Service charge per foot	1.20
for ⅝ in. AA Lead Service	
1—⅝ in. corporation cock and tapping	5.00
1—⅝ in. curb cock, curb box and rod	7.00
Service charge per foot	1.20
for ¾ in. AA Lead Service	
1—¾ in. corporation cock and tapping	5.50
1—¾ in. curb cock, curb box and rod	8.00
Service charge per foot	1.30
for 1 in. AA Lead Service	
1— 1 in. corporation cock and tapping	7.00
1— 1 in. curb cock, curb box and rod	9.50
Service charge per foot	1.50

The above charges include all common labor and service of plumber making the installation. In case the service is installed in a paved street the additional labor necessary in making the necessary opening through the pavement is charged for in addition to the regular installation charge as per above schedule.

Rensselaer—The company does the work and the consumer pays for same as follows: ⅝ in. tap, including lead connection, curb stop and box, $9; ¾ in. tap, including lead connection, curb stop and box, $10; 1 in. tap, including lead connections, curb stop and box, $12.

Rochville Centre—$2.50 each.

Rye—$2.60 for ⅝ in. tap and $26.50 for ¾ in. (This does not include making repairs to the street.) For macadam repairs the village charges 50 ct. per sq. ft. and for Hasting block 80 ct. per sq. ft.

Rochester—Charge is made for the tap—according to size—including insertion in main. Types of street not considered by the bureau at all. The plumber makes bargain with the owner for the whole job.

Scotia—$10.

Schenectady—½ in. tap, $70; ¾ in. tap, $9; 1 in. tap, $11. The street department makes a charge of $10 for the first sq. yd. of asphalt, etc., cut and an additional charge of $3 for each yard thereafter. This is in addition to charge made for tapping.

Sherrill—District taps main—no charge and furnished curb box, corporation cock. Consumer lays all connections. We allow to consumer who is on far side of the street an upset figure for approximately twice the distance from main to center of street, thus putting on same lead as the near consumer who gets no allowance toward cost of his connection. Consumer pays for meter also. Our upset figure is $0.65 a foot for all sorts of road or pavement. We used to have a price for each sort, but treat all as costing at least $0.66. Probably most cases cost actually more than we allow.

Saratoga—⅝ in. tap, $6; ¾ in. tap, $8; 1 in. tap, $10.

Salamanca—Consumer pays for all connections to the main, also pays for all damage to street. If leak develops on consumer's line he is notified to have same repaired; if it is not taken care of, water department opens up street and shuts off water, and water is not turned on until necessary repairs are made and bill paid for opening up street and shutting off water.

Scarsdale—¾ in. tap, $10; 1 in. tap, $12; 1¼ in. tap, $20; 1½ in. tap, $28; 2 in. tap, $35.

Tonawanda—$4 for ⅝ in. tap (made by city); 33 ct. a foot for ⅝ AA lead pipe; $2.50 for curb box; $2 for curb cock. The lead, curb box and curb cock are sold by the city to the plumber doing the work, the tap is also charged to plumber, who charges same to consumer.

Tarrytown—¾ in. tap at $3.20 each; 1 in. tap at $4 each; larger taps or tee connections at cost.

Troy—¾ in. corporation cock, curb cock, curb box tapping, $14.25; 1 in. corporation cock, curb cock, curb box, tapping, $17.35; 1¼ in. corporation cock, curb cock, curb box, tapping, $27.50; 1½ in. corporation cock, curb cock, curb box, tapping, $36.50; 2 in. corporation cock, curb cock, curb box, tapping, $49.50. Labor and lead pipe are extra.

Valley Stream—This village has no municipal water supply. Water supplied by a private corporation. The municipality charges $2.50 for each street opening on dirt surface roads, the plumber who makes application for the permit paying the fee. The paved roads have just been laid, and no openings will be permitted for six months.

Watertown—$20 for ¾ in. connection; $25 for 1 in. connection; above 1 in. is put in at cost. In addition to the above charge, there is always an additional charge for replacing the pavement, which varies from 50 ct. to $5 per sq. yd.

New York—Schedule of charges for furnishing and installing wet connections:

Pipe in.	Size of Connection in.	Total Cost Minus Valve Box	Total Cost of Valve Box and Cover	Total Cost
4	2	$ 34.50	.....	$34.50
6	2	38.25	.....	38.25
6	3	43.00	.....	43.00
6	4	48.00	$10.25	58.25
8	2	41.75	.....	41.75
8	3	47.25	.....	47.25
8	4	53.50	10.25	63.75
8	6	75.25	10.25	85.50
10	2	46.75	.....	46.75
10	3	53.25	.....	53.25
10	4	59.25	10.25	69.50
10	6	82.23	10.25	92.50
10	8	108.75	10.25	119.00
12	2	53.00	.....	53.00
12	3	58.25	.....	58.25
12	4	64.75	10.25	75.00
12	6	87.25	10.25	97.50
12	8	115.75	10.25	126.00
14	2	61.75	.....	61.75
14	3	66.75	.....	66.75
14	4	78.25	10.25	98.00
14	6	104.75	10.25	115.00
14	8	136.25	10.25	148.50
16	2	68.25	.....	68.25
16	3	75.75	.....	75.75
16	4	82.50	10.25	92.75
16	6	110.00	10.25	120.25
16	8	138.75	10.25	149.00
16	12	207.50	10.25	217.75
20	2	82.75	.....	82.75
20	3	87.75	.....	87.75
20	4	99.75	10.25	110.00
20	6	125.50	10.25	136.75
20	8	159.25	10.25	169.50
20	12	237.50	10.25	247.75
24	2	109.25	.....	109.25
24	4	128.00	10.25	138.25
24	6	154.00	10.25	164.25
24	8	199.00	10.25	209.25
24	12	302.50	10.25	312.75
30	2	127.00	.....	127.00
30	4	143.75	10.25	154.00
30	6	198.25	10.25	202.50
30	8	229.75	10.25	240.00
30	12	313.75	10.25	324.00
36	2	183.50	.....	183.50
36	4	201.50	10.25	211.75
36	6	234.25	10.25	244.50
36	8	275.50	10.25	285.75
36	12	373.00	10.25	383.25
48	6	382.25	10.25	392.50
48	8	439.50	10.25	449.75
48	12	609.50	10.25	619.75
48	20	962.50	10.25	972.75

The following is a list of the charges for

Screw Taps

¾ in.	$ 4.50
1 in.	5.00
1 in.	6.00
1½ in.	12.00
2 in. on 12 in. main	15.00

Yonkers—Furnish and tap main, tap has coupling for lead pipe, furnished by city. Cost of plumber, ⅝ in. tap, $6; cost of plumber, ¾ in. tap, $7; cost of plumber, 1 in. tap, $9; cost of plumber, 1½ in. tap, $17; cost of plumber, 2 in. tap, $27. Larger sizes we have a deposit made to cover cost of same. Charges for street openings are regulated as to kind of pavement. $50 granite rock; $40 asphalt; $40 penetration; $5 macadam.

Malone—The water department makes the tap, furnishes the shut off, curb cock and curb box, after the consumer has the excavating done.

Saranac Lake—Consumer pays for all material—opens and fills the trench—the board makes the tap and installs the brass connections. The municipality furnishes pipe and labor to lay private connection from main to curb.

East Rochester—Labor and material at cost.

Syracuse—Where application for service is made on a paved street the owner of property is required to make a deposit to cover the cost of repairs to pavement. After repairing pavement refund is made for the difference of the deposit and cost of repair. This is the only charge on services where water is put in. Fire services are laid by the bureau of water and entire cost is paid for by the property owner, as there is no charge for water used on fire services as they are used only in case of fire.

Waverly—$7.

Rates Paid by Large Cities for Water for Municipal Purposes

The following information on the above subject was taken from *Municipal News and Water Works:*

Questionnaires were sent to the 33 cities of over 200,000 population in this country.

The following cities report some payment from the city:

Akron—"Small amount annually."

Buffalo—Four cents per 1,000 gal. (1924 information). No hydrant rental.

Denver—"Some departments supplied free, others at reduced rates."

Indianapolis (private company)—Rate not given. Water for hydrants supplied on inch-foot basis with nominal annual rental.

Milwaukee—Regular rates. Hydrant rental $10 per year per hydrant.

Minneapolis—Free water for general city service. Parks and libraries pay 4 ct. per 100 gal.

Oakland (private company)—Regular rates for metered service. Public use charge based on number of feet of streets piped and number of hydrants: $10 to $50 per year per 1,000 ft. piped according to size of main, and $8 to $10 per hydrant per year if owned by the company, or $3 to $5 if owned by city. Basic charge for public use in 1917 was $105,500.

Omaha—No charge for city buildings or for flushing streets. All water used for sanitary sewer systems in excess of 50,000 gal. per flush tank per month charged for at regular rates. Hydrants $60 per year.

Philadelphia—Schools and charitable institutions, 6 ct. per 1,000 cu. ft.

Pittsburgh—Public buildings at hotel rates. Charitable institutions and schools have free allowance, then 7 ct. per 1,000 gal. (1924 information).

Portland—$75,000 per year.

Providence—Most municipal supplies pay regular rates. No hydrant charge (1924 information).

Rochester—$150,000 per year.

St. Louis—Schools and libraries, 6 ct. per 100 cu. ft. Charitable institutions, 4½ ct. per 100 cu. ft. No hydrant charge.

St. Paul—Regular rates. Hydrant charge $14 per year per hydrant.

San Francisco (private company)—Regular rates. Hydrants, $5 per month per hydrant.

Seattle—For flushing streets, $14,400; for hydrants, $9 per year per hydrant.

The remaining cities considered in the compilation report no charge for water supplied for municipal purposes.

Jersey City has a book charge of $75,000 a year. In Detroit hydrants are furnished and maintained by the fire department. No recent information has been received for Atlanta, Boston, Jersey City or New Orleans. These cities in 1924 reported free water.

No information is available for Baltimore.

GEORGE H. SNELL COMPANY

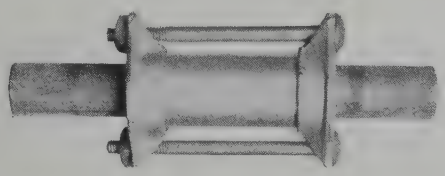
Attleboro, Massachusetts

Manufacturers of Threadless Pipe Couplings and Tees

Products: SNELL THREADLESS PIPE COUPLINGS AND TEES FOR WATER PIPES, COMPRESSED AIR LINES, MINE WATER AIR LINES, PLUMBERS' SERVICE CONNECTIONS AND METER CONNECTIONS.

Snell's Couplings and Tees have been used extensively in the above fields for over a quarter of a century, giving absolute satisfaction.

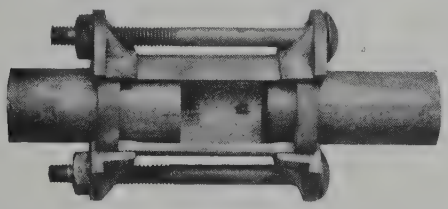
Snell's Couplings and Tees are Threadless. No pipe threading required. Guaranteed to stand the strain of 250 lbs. pressure. Forms a perfect expansion joint for overcoming



electrolysis. All pipe lines, particularly those carrying water and gas, should be Snell Coupled. Regardless of what kinds of pipe you are using we believe, considering first cost, general efficiency, low maintenance expenses and other factors entering into the construction and operation of Water and Gas Lines, a Snell Coupled Line will give more service per dollar than any other.

As a pipe line, like a chain, is no stronger than its weakest link or joint, it behooves one to purchase the best coupling the market affords. Snell couplings combine flexibility with strength which care for expansion and contraction as well as settling ground.

Installing Couplings and Tees: The Snell Easy On Threadless Couplings and Tees are rightly named. There are only



two bolts, pipe does not have to be in alignment, no threads to cut or screw up, and a tight connection guaranteed, very little pressure on the bolts to make a permanent, lasting connection.

For Making Repairs: Using Snell Couplings and Tees saves cutting threads in trenches, and using unions, does not require so large a trench and pipe does not have to be in line. Can be put on under water when necessary and repairs can be made when ordinarily would be impossible to use any other fitting, thereby saving entirely new construction.

Make-Up of Snell Couplings and Tees: Ends—Grey Iron Castings. Barrels—Seamless Steel Tubing. Rubber Gaskets —Special Compound for both Water and Gas. Bolts—Coppered and Nickeled. Combined with our process of hot galvanizing over all in making the Snell Couplings and Tees is your solution in reducing your pipe line troubles to an absolute minimum.

Showing the Way Tees Are Used in Making a Connection on a Small Main in the Ground or Inside of Buildings

Durability of the Rubber Gasket: (Also made in Brass). Owing to the manner in which the rubber is compressed in the recess of the flange, and against the barrel of the coupling, also the pipe, it is practically hermetically sealed. The perfect compression makes it impossible for any deterioration to take place, and consequently will last as long as the pipe itself.

TEES

Sizes	Over All Length	Weight	Sizes	Over All Length	Weight
½x½x½	4¾ ins.	1 lb. 4 oz.	2x2x¾	8 in.	7 lb. 8 oz.
¾x¾x¾	5 "	1 " 12 "	2x2x1	9 "	7 " 8 "
1x1x¾	6 "	2 " 10 "	2x2x1¼	9 "	7 " 10 "
1x1x1	6 "	2 " 14 "	2x2x1½	9 "	7 " 12 "
1¼x1¼x¾	7 "	4 "	2x2x2	9 "	8 "
1¼x1¼x1	7 "	4 "	2½x2½x2	12 "	16 " 4 "
1¼x1¼x1¼	7 "	4 " 8 oz.	2½x2½x2½	12 "	17 " 8 "
1½x1½x¾	7½ "	4 " 14 "	3x3x2	14 "	23 " 8 "
1½x1½x1	7½ "	4 " 14 "	3x3x3	14 "	24 " 12 "
1½x1½x1¼	7½ "	5 " 4 "	4x4x2	15 "	29 "
1½x1½x1½	7½ "	5 " 6 "	4x4x3	15 "	30 "
			4x4x4	15 "	31 " 8 "

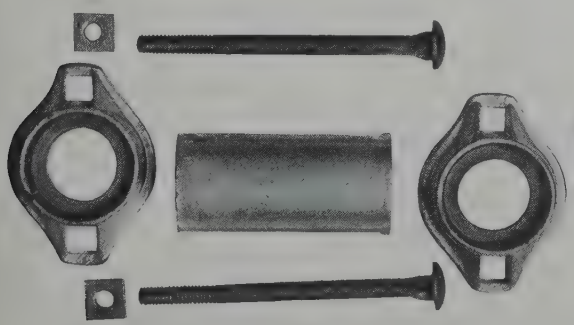
COUPLINGS

Sizes	Length	Weight	Sizes	Length	Weight
½	3¾ in.	1 lb.	2	6 in.	4 lb. 10 oz.
¾	3⅞ "	1 " 6 oz.	2½	11¼ "	14 "
1	4⅜ "	2 " 4 "	3	14 "	20 "
1¼	5 "	2 " 12 "	4	14 "	23 "
1½	6 "	3 " 12 "	6 in.	13 "	40 "
			8 in.	13 "	77 "

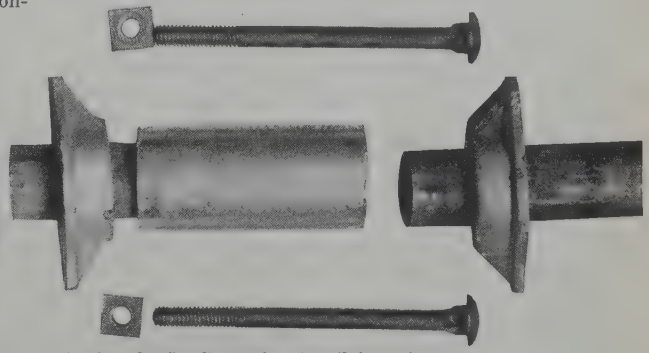
For McWane C. I. Pipe: 1¼ in., 2 in., 1¼x1¼x1 Tee, 2x2x1 in. Tee.

Prices on Larger Sizes upon application. In Brass, prices slightly higher.

Descriptive literature on request.



Showing the Parts of the Coupling Ready to Put on the Pipe



Showing the Coupling Being Installed on the Pipe, Ready to Slip Over the Opening and Be Bolted Together

Compressed Air Terms

Nomenclature and Terminology

From the Standards of The Compressed Air Society

In the advances made in the use of compressed air many terms and expressions have been adopted and it is felt necessary for a complete and thorough understanding of compressors and the uses of compressed air that these terms be clearly defined.

Compressors.—A compressor is a machine designed for compressing air or gas from an initial intake pressure to a higher discharge pressure. Machines built for accomplishing this work are made in various styles or classes.

Turbo, Rotary and Centrifugal Compressors.—These are machines in which the compressing element is of the rotating construction.

Reciprocating Compressors.—These are machines in which the compressing element is of the reciprocating construction.

The following definitions apply to reciprocating compressors:

Vertical Compressors.—A vertical compressor has the compressing element in a vertical position.

Horizontal Compressors.—A horizontal compressor has the compressing element in a horizontal position.

Angle Compressors.—An angle compressor is of the multicylinder type with part of the compressing element located horizontally and part of the compressing element located vertically.

Straight Line Compressors.—In this class of machine the driving and compressing elements are placed in a horizontal position and in line with one another.

Duplex Compressors.—Duplex compressors consist of two straight line units placed parallel on one common crank shaft.

Single Acting Compressors.—A single acting compressor consists of one or more compressing units, the compression taking place on but one stroke per revolution in each compressing element.

Double Acting Compressors.—A double acting compressor consists of one or more compressing units, the compression taking place on both strokes per revolution in each compressing element.

Single Stage Compressors.—When air or gas is compressed in each cylinder from initial intake pressure to final discharge pressure on each working stroke of the piston the machines are said to be of the single stage type.

Two-Stage and Multi-Stage Compressors. When air or gas is compressed from initial intake pressure to final discharge pressure in two distinct steps, the machine is said to be of the two-stage type.

More than two distinct steps can be used in compressing air or gas to its final pressure, and machines so constructed are spoken of as multi-stage machines, or as three or four stage machines, depending on the number of distinct compressing stages.

Air Cooled Compressors. Air cooled compressors are those machines having radiating fins cast on the cylinder walls and in which the cooling of the compressor cylinder is obtained through the circulation of atmospheric air around the compressor cylinder.

Water Cooled Compressors. Water cooled compressors are machines in which the compressor cylinders are colled by the circulation of water through jacketed spaces adjacent to the cylinder.

Hopper Jacketed Compressors. Hopper jacketed compressors are constructed so that the jacketed space around the compressor cylinder forms an open reservoir to be filled with cooling water.

Portable Compressors. A portable compressor is a complete air compressor plant consisting of compressor, prime mover and air receiver all mounted on a chassis so that it may be readily moved.

Semi-Portable Compressors. A semi-portable compressor is a complete machine skidded or, one that can be moved about from place to place but not on its own wheel base.

Intercooler. A device for removing the heat of compression between the stages of compression on compound or multiple stage compressors.

Inlet Valve. A device for admitting air or gas into the cylinder and to prevent its return when being compressed.

Discharge Valve. A device for permitting the discharge of compressed air or gas from the compressor cylinder and to prevent its return to the cylinder.

Air Receiver. A receptacle into which the compressed air or gas is discharged from the compressor. A receiver helps to eliminate pulsations in the discharge line. It also acts as storage capacity during intervals when the demand exceeds the capacity of the compressor.

Moisture Trap. A means for collecting and removing moisture, precipitated from the air or gas during the process of cooling.

Aftercooler. A means for reducing the heat of compression generated in the final stage of compression and also one of the most effective methods of removing moisture from compressed air.

Reheater. A means for raising the temperature of compressed air.

Air Filters. An air filter as used on compressors is a device for removing the small particles of dust and dirt from the air going into the machine.

Standardizing Hand of Compressor. To avoid misunderstandings it is recommended that the following be observed in determining the right or left hand side of a compressor:

Standing at the air cylinders of a duplex machine and looking toward the power end, the frame to the right is designated as the right hand side and the one to the left is designated as the left hand side.

Identifying Cylinder Heads. The head of an air cylinder next to the frame is designated as "the frame end cylinder head." The head at the other end of an air cylinder is designated as "the outer cylinder head."

Definitions

From the Trade Standards of The Compressed Air Society

Absolute Temperature. Absolute temperature on Fahrenheit scale is the reading of the thermometer in degrees Fahrenheit plus 459.6 degrees.

Absolute temperature on Centigrade scale is the reading of the thermometer in degrees Centigrade plus 273 degrees.

Isothermal Compression. That case of compression where the gas does not change in temperature during compression. Compression curve follows Boyle's law that $PV = P_1V_1$ or $PV = K$ where P = absolute pressure; V = volume of gas present; K = constant.

Adiabatic Compression. That case of compression where during compression the temperature of the gas can rise unchecked, namely, where there is no transfer of heat to or from the fluid being compressed.

The equation of the adiabatic compression curve is $PV^n = K$, where P = absolute pressure; V = volume of gas present; K = constant; n = coefficient; the ratio of specific heat at constant pressure to specific heat at constant volume. For air it is 1.406 (usually expressed as 1.41).

Displacement. The displacement of a compressor is the volume displaced by the net area of the compressor piston multiplied by the length of stroke and by the number of strokes per minute. For compound and multi-stage machines only the low pressure cylinder is considered.

Free Air. By free air is meant air at normal atmospheric conditions. Because the altitude, barometer and temperature vary at different localities, it follows that this term does not mean air under identical conditions.

Considerable confusion has existed regarding the term "free air" and it has been interpreted to be air at sea level conditions, namely, at an absolute pressure of 14.7 pounds per square inch and at a temperature of 60 degrees Fahrenheit. We feel that this is not the correct interpretation of the expression "free air," and that "free air" is the normal atmospheric condition of the air at the point where the compressor is installed.

Capacity (Actual). The capacity of an air or gas compressor is the actual amount of air or gas compressed and delivered, expressed in cubic feet per minute at intake temperature and pressure. The delivery measurement to be as actually made by low pressure orifice test.

Volumetric Efficiency. The volumetric efficiency is the ratio of the capacity of the compressor to displacement.

Compression Efficiency. Compression efficiency is the ratio of the theoretical power required to compress the

amount of air or gas actually delivered to the actual power required in the compressor cylinder as shown by indicator diagrams.

The theoretical power may be calculated according to the isothermal base, or according to the adiabatic base, and the compression efficiency correspondingly defined.

Mechanical Efficiency. Mechanical efficiency is the ratio of the air indicated horsepower to the indicated horsepower in the power cylinders, in the case of steam driven or internal combustion engine driven compressors, and to the brake horsepower delivered to the shaft in case of a power driven machine.

Overall Efficiency. The overall efficiency is the product of the compression efficiency and the mechanical efficiency.

Load Factor. The load factor is the ratio of the average compressor load during a certain period of time to the maximum rated load of the machine.

Low Pressure Orifice Test.—A method of accurately measuring the air delivered by a compressor. The method of conducting a low pressure orifice test is given in section three, with the terms used.

Formulas for Pumps and Piping

From the Mining Catalog

TO FIND:	GIVEN:	FORMULAS:
1. Pressure in lb. per sq. in.=P.	Head in ft.=H.	$P=H\times 0.433.$
2. Head in feet=H.	Pressure in lb. per sq. in.=P.	$H=P\times 2.312.$
3. Horse power required to raise water (theoretical).	Gallons per Min.=G. Head in ft.=H.	$HP=\frac{G\times H}{33{,}000}$
4. Volume of water discharged by pipe (neglecting bends and friction).	Internal dia. of pipe in inches=D. Head in ft.=H. Length of pipe in yd.=L.	$\text{Gal. per min.}=\sqrt{\frac{D^5\times H}{L}}$
5. Theoretical capacity of single acting pump.	Area of ram in square inches=A. Stroke in inches=S. No. of strokes per min.=N.	$\text{Gal. per min.}=\frac{A\times S\times N\times 62.5}{1728}$
6. Diam. in inches of single acting pump to deliver given number of gals. per stroke.	Gal. per stroke=G. Stroke in ft.=S.	$\text{Dia. of pump}=\sqrt{\frac{31\,G}{S}}$ (Allowing 5% waste.)
7. Feet head lost by friction in pipes=F.	Gal. per min.=G. Length of pipe in yd.=L. Internal diam. of pipe in in.=D.	$F=\frac{G^2\times L}{(3\,D^5)}$
8. Approx. weight of water in vertical pipes in lb.=W.	Internal diam. of pipe in in.=D. Length of pipe in yd.=L.	$W=D^2\times L$
9. Thickness of cast iron pipes in inches=T.	Internal diam. of pipe in in.=D. Pressure in lb. per sq. in.=P.	$T=\frac{D\times P}{4000}+0.3$
10. Delivery per stroke of single acting pump.	Diam. of plunger in in.=D. Stroke in ft.=S.	$\text{Gal. delivered per stroke}=\frac{D^2\times S}{31}$ (Allowing 5% waste.)
11. Speed of water through pipes in ft. per sec.	Area of pipe in sq. in.=A. Discharge in cu. ft. per min.=F.P.M.	$\text{Velocity ft. per sec.}=\frac{FPM\times 2.4}{A}$
12. Velocity in ft. per sec. due to head=V.	H=Head. g=32.2 Gravity.	$V=\sqrt{2gH}$
13. Head from velocity.	.....	$H=\frac{V^2}{2g}$
14. Imperial gallons.	Cubic feet=C.	Imperial gallons=C×62.5
15. Cubic feet.	Gallons (Imperial)=G.	Cubic feet=G×0.16

SCHRAMM, INC.

West Chester, Pa.

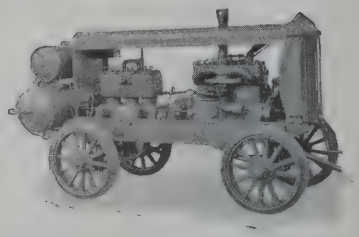
Manufacturers of Air Compressors

New York Philadelphia Pittsburgh Chicago Tulsa San Francisco

Representatives in All Principal Cities

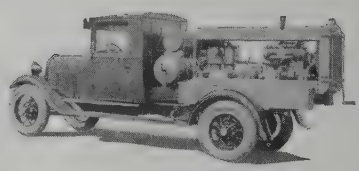
Products: AIR COMPRESSORS.

"Schramm" Multi-Cylinder Air Compressor on Standard Steel Wheel Truck

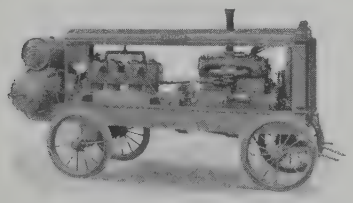


"Schramm" Multi-Cylinder Air Compressor on Spring Equipped Artillery Wheel Trailer

"Schramm" Multi-Cylinder Air Compressor on Wooden Skids

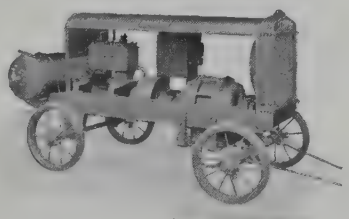


"Schramm" Engine Driven Compressor for Mounting on Various Type Motor Trucks

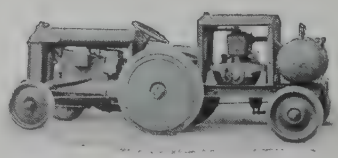


"Schramm" Multi-Cylinder Air Compressor on Rubber Tire Steel Spoke Wheels

"Schramm" Multi-Cylinder Air Compressor with Side Doors in Place



"Schramm" Direct-Connected Motor Driven Portable Compressor



"Schramm" Compressor Tractor Combination

SCHRAMM Multi-Cylinder Portable Air Compressors are built in sizes of 60, 120, 180, 240 and 360 cu. ft. displacement per minute.

Gasoline operated compressors are equipped with heavy duty BUDA engines. The SCHRAMM clutch, a distinctive SCHRAMM feature, installed between engine and compressor permits starting of engine independent of the compressor. All sizes, with exception of 60 cu. ft. are mounted on one piece cast steel frames. The special "SCHRAMM" slow-down governing device automatically cuts engine speed to a minimum as soon as compressor unloads, thereby saving much fuel and wear.

These same compressors may be had for electric motor drive.

SCHRAMM compressors may be had on steel wheels, rubber tires, or the SCHRAMM spring equipped trailer. In addition the units may be obtained skidded for semi-portable installations, or for mounting on standard automobile truck chassis.

SCHRAMM compressors for attaching to the Fordson, or the McCormick-Deering tractors are furnished in sizes ranging from 60 to 160 cu. ft.

Send for complete Catalog.

SULLIVAN MACHINERY COMPANY

ESTABLISHED 1850

830 Wrigley Bldg., Chicago, Ill.

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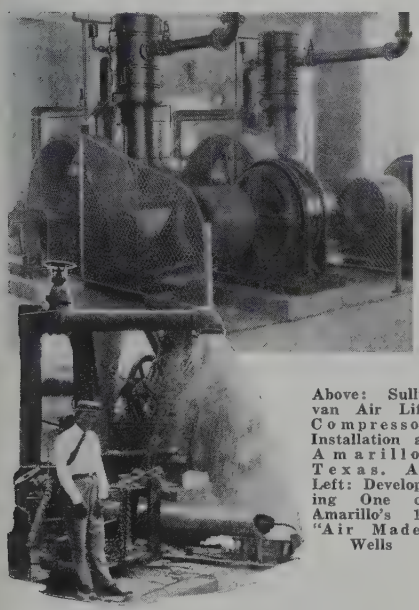
WORKS: Claremont, N. H., and Michigan City, Ind.

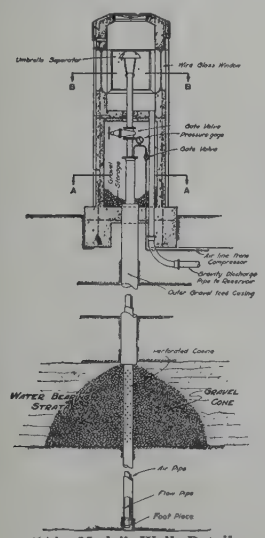
Products: Air Compressors, Stationary and Portable; Air Lift Pumping Systems; Rock Drills; Concrete Breakers; Clay Spaders; Portable Hoists; Pavement Core Drills.



Above: Sullivan Air Lift Compressor Installation at Amarillo, Texas. At Left: Developing One of Amarillo's 10 "Air Made" Wells

Sullivan Air Lift Water Supply: For municipal water supply, Air Lift has several important advantages over mechanical pumping systems. There are no moving parts in the well and consequently no trouble is experienced from mud or sand, crooked wells, or varying water levels. As the power for pumping the water is supplied by Sullivan Air Compressors, the entire system is economical and trouble-free. **Catalog 8481-I.**

Automatic Air Lift: Sullivan Air Lift, completely automatic systems, have been installed in many instances. Air Lift delivers water to ground level, from where it is lifted to mains or elevated tank by a centrifugal pump. A float switch starts and stops the compressor and pump automatically.

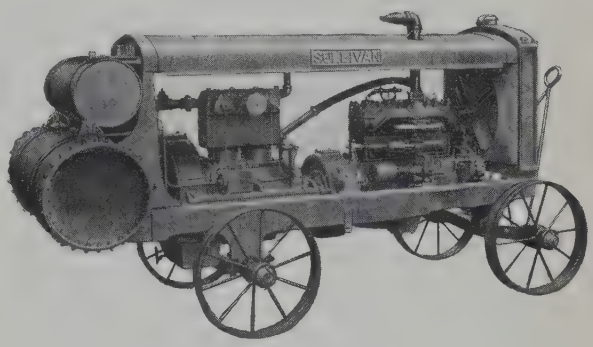


"Air Made" Well Detail

"Air Made" Wells: Nearly everyone has heard about "Air Made" Wells, and how they have given many districts permanent dependable water supply systems. But the full significance of this new development, is not always grasped. Where a municipality must depend on shallow sand strata for water, the "Air Made" Well is indispensable, as it furnishes the only means of securing a permanent, undiminishing supply.

But where both shallow sand and deep rock sources of water are available, the "Air Made" Well saves the cost of lifting water from great depths. See **Catalog 8456-J.**

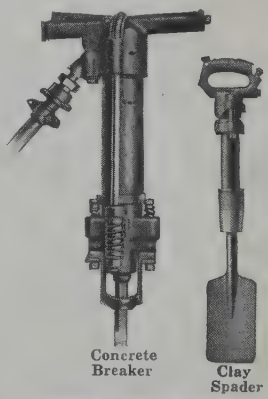
Sullivan Portable Air Compressors: With trench digging, and pipe laying, and repairing being speeded up everywhere with Air Power, a trouble-free portable air compressor like the Sullivan "Vibrationless" machine, offers you an exceptionally profitable investment.



110-Ft. Portable Compressor

Sullivan "Vibrationless" Compressors run so smoothly that a glass of water filled to the brim will stand on the frame of the machine, running under full speed and load. This is due to perfect static and dynamic balance, to harmony of power impulses with load demands, to flywheels on both engine and compressor, and to four "balanced-V" cylinders on the big models.

Sullivan Compressors are available in capacities of 103, 110, 160, 206, 220, and 310 cu. ft. sizes; on steel wheels, trailer trucks, or on skids ready for mounting on your own truck; and with gasoline engines, or electric motors. **Catalog 8483-F.**

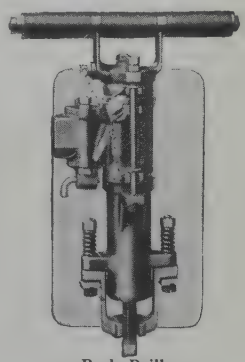


Concrete Breaker

Clay Spader

Sullivan Air Tools: Sullivan Rock Drills, Concrete Breakers, and Clay Spaders are furnished in numerous models, to speed up trench digging and pipe laying and repairing. Send for the picture book "Speed Up With Air."

Sullivan Portable Hoists: Sullivan 345 lb. hoists will lift a ton on single line, or pull a 50 ton car on level track. They are dependable machines which will save you time and money in handling pipe, well casing, and other equipment. **Catalogs 8476-F, 8476-G.**



Rock Drill

Pumps

Definitions and Values

Adopted by The Hydraulic Society

Efficiency, Hydraulic (Symbol e_h).—The ratio of the useful power delivered in the water at the point of discharge where measured to the power delivered to the water by the impeller at the point of exit from the impeller.

Efficiency, Mechanical (Symbol e_m).—The ratio of the water horsepower to the horsepower required to drive the pump.

Efficiency, Overall (Symbol e).—Comprises all the losses in the pump and the driver, and indicates the economy of the entire unit.

Head, Total Dynamic (Symbol T.D.H.).—Total dynamic head is the vertical distance between the source of supply and point of discharge when pumping required capacity, plus friction entrance and exit losses.

Total dynamic head, as determined on test, where suction lift exists, is the reading of a mercury column connected to the suction nozzle of pump, plus the reading of a pressure gauge connected to discharge nozzle of pump, plus vertical distance between point of attachment of mercury column and center of gauge, plus excess, if any, of velocity head of discharge over velocity head of suction as measured at points where the instruments are attached, plus head of water resting on mercury column, if any.

Total dynamic head, as determined on test, where suction head exists, is the reading of a gauge attached to the discharge nozzle of pump, minus the reading gauge connected to the suction nozzle of pump, plus or minus vertical distance between centers of gauges (depending on whether suction gauge is below or above discharge gauge) plus excess, if any, of velocity head of discharge over velocity head of suction as measured at points where instruments are attached.

Total Dynamic Discharge Head is the total dynamic head minus dynamic suction lift, or plus dynamic suction head.

Head, Static (Symbol H_s).—Static head is the vertical distance between the free level of the source of supply and to the point of free discharge, or to the level of the free surface of the discharge water.

Head, Velocity (Symbol H_v).—The velocity head (sometimes called "Head due to Velocity"), of water moving with a given velocity, is the equivalent head through which it would have to fall to acquire the same velocity; or, in other words, the head necessary merely to accelerate the water. Knowing the velocity, we can readily figure the velocity head from the simple formula:

$$h = \frac{V^2}{2g}$$

in which "g" is acceleration due to gravity, or 32.16 feet per second; or, knowing the head, we can transpose the formula to:

$V = \sqrt{2gh}$, and thus obtain the velocity.

The velocity head is a factor both in figuring the total head from construction data and testing.

When estimating the total dynamic head of an installation, the head equivalent to the velocity of the water leaving the end of the discharge pipe line must be added to the static and friction head.

When testing a pump, certain velocity head corrections must be made, depending on the average velocity at the point where pressure readings are taken. The customary method of testing is to use a mercury column for obtaining the suction lift and a gauge to indicate the discharge or suction head, with gauge connections at or close to the pump openings.

The mercury column at the suction will show the dynamic suction head at the point of gauge connection. Included in this dynamic suction head is the velocity head as represented by the average velocity at that point.

The discharge gauge will show the dynamic pressure head at the point of gauge connection.

The sum of the two gauge readings, corrected to the same elevation will give the total dynamic head produced by the pump provided water flows at the same average velocity at the point of attachment of suction gauge as of discharge gauge. This condition will exist when suction and discharge openings are of equal size.

If the discharge pipe is of smaller diameter than the suction pipe, which is often the case, then it will be necessary to add to the total head, as shown by the gauges, the difference in velocity head between that of the discharge and that of the suction pipe at the point where gauges are connected.

If the discharge pipe is larger than the suction pipe, the difference in velocity head must be subtracted from the total head.

Velocity ft. per second	1	2	3	4	5	6	7
Velocity head in ft.	.02	.06	.14	.25	.39	.56	.76
Velocity ft. per second	8	8.5	9	9.5	10	10.5	
Velocity head in ft.	1.0	1.12	1.25	1.4	1.55	1.7	
Velocity ft. per second	11	11.5	12	13	14	15	
Velocity head in ft.	1.87	2.05	2.24	2.62	3.05	3.5	

Horsepower, Brake (Symbol b-hp.).—The actual horsepower required at the pump shaft to drive the pump $= \frac{\text{w-hp}}{e_m}$. Brake horsepower is not applicable to direct-acting steam pumps.

Horsepower, Indicated (Symbol i-hp.).—The horsepower developed in the steam or liquid end calculated from indicator cards.

Suction Head (sometimes called head on suction) exists when the pressure measured at the suction nozzle and corrected to the center line of the pump is above atmospheric pressure.

Suction Head Dynamic, where static suction head exists, is the vertical distance from the source of supply, when pumping at required capacity, to center of pump, minus velocity head, minus entrance, friction and velocity losses; but not minus internal pump losses.

Suction head dynamic, as determined on test, is the reading of a gauge connected to suction nozzle of pump, minus vertical distance from center of gauge to center line of pump. Suction head, after deducting the various losses, may be a negative quantity, in which case a condition equivalent to suction lift will prevail.

Suction Head Static exists when the source of supply is above the center of pump and is the vertical distance from the free level of the source of supply to center of pump.

Suction Lift.—Suction lift exists when the suction measured at the pump nozzle and corrected to the center line of the pump is below atmospheric pressure.

Suction Lift Dynamic, where static suction lift exists, is the vertical distance from the source of supply, when pumping required capacity, to center of pump, plus velocity head, plus entrance, friction and velocity losses, but not including internal pump losses; where static suction head exists but where the losses exceed the static suction head the dynamic suction lift is the sum of the velocity head, entrance, friction and velocity losses, **minus** the static suction head, but not including internal pump losses.

Suction lift dynamic, as determined on test, is the reading of a mercury column connected to suction nozzle of pump, plus vertical distance between point of attachment of mercury column to center of pump, plus head of water resting on mercury column, if any.

Suction Lift Static exists when the source of supply is below the center of pump and is the vertical distance from the free level of source of supply to center of pump.

Viscosity is that property of a liquid which resists any force tending to produce flow. Viscosity is a property independent of specific gravity.

Prime Movers

Definitions and Values

Extracts from the American Society of Mechanical Engineers' Power Test Codes, 1923. Approved Dec. 1, 1924, and Subject to Revision. Taken from Standards of Hydraulic Society

Atmosphere (Symbol atmos.).—760 mm. mercury at ice point and standard gravity = 14.7 lb. at sea level.

British Thermal Unit (Symbol B.t.u.).—1/180 of the heat required to raise 1 lb. mass of water from the ice point to the steam point under constant pressure of 1 atmosphere.

Efficiency, Cycle (Symbol e_c).—Cycle efficiency is the ratio of heat available for conversion into work to the total heat supplied. This efficiency is often referred to as the efficiency of the ideal engine.

Efficiency, Engine (Symbol e_e).—Engine efficiency is the ratio of heat converted to work in the actual engine to the heat available for conversion to work by the cycle employed, or it is equivalent to the actual work done by the engine, divided by the work which could be done by a perfect engine on the same cycle. Engine efficiency is usually determined from a measured thermal efficiency and a calculated efficiency. For steam engines and turbines, all heat cycles are composed of one or more Rankine cycles. Exact knowledge of the steam cycle and a determination of its cycle efficiency is necessary to obtain engine efficiency from a measured thermal efficiency. A single-expansion steam engine or turbine always operates on a simple Rankine cycle. Multiple-cylinder engines or turbines, in which heat is added or abstracted between cylinders, operate on a number of different Rankine cycles, whose cycle efficiency must be determined for several actual heat quantities and pressure difference. The cycle efficiency of this composite cycle is different from the efficiency of a single Rankine cycle covering the entire range.

The term "Engine Efficiency" may thus be amplified if desired, by writing "Engine Efficiency on the Rankine Cycle," or "Engine Efficiency (Rankine)." It must be understood, however, that this is a distinctly different thing from the Rankine Steam Cycle Efficiency as defined in Paragraph 5. The term "Rankine Efficiency" has been used for both of these things and it must be noted that its use is here abandoned for this reason. The term "Engine Efficiency" may also be amplified by writing "Engine Efficiency of a Turbine-Generator" or "Engine Efficiency of Turbine only." It is not desirable to use such terms as "Turbine-Generator Efficiency" or "Turbine Efficiency." This term may be further amplified when necessary by prefixing the word "Indicated" or "Brake."

Efficiency, Rankine Steam Cycle.—This is the heat cycle efficiency, defined in Par. 3 of the Rankine steam cycle.

$$e_r = \frac{h_1 - h_2}{h_1 - h_3}$$

where h_1 = heat content of steam, at initial condition
h_2 = heat content of steam after adiabatic expansion
h_3 = heat content of the liquid at exhaust pressure

Efficiency, Thermal (Symbol e_t).—Thermal efficiency is defined as the heat equivalent of the work done divided by the heat supplied.

Thermal efficiency of a steam engine or turbine on any steam cycle without reheat or extraction is expressed as follows:

For steam engines:

Indicated thermal efficiency,

$$e_i = \frac{2545}{w_i\,(h - h_1)}$$

For steam engines and turbines:

Brake thermal efficiency,

$$e_b = \frac{2545}{w_b\,(h - h_1)}$$

For engine generators and turbo-generators:

Combined thermal efficiency,

$$e_k = \frac{3413}{w_k\,(h - h_1)}$$

Where w_i = Steam rate referred to indicated horsepower
w_b = Steam rate referred to brake horsepower
w_k = Steam rate referred to net kilowatts
h = Heat content, B.t.u. per lb. at the throttle
h_1 = Heat returnable to boiler, B.t.u. per lb.

The thermal efficiencies of the internal combustion engine are expressed as follows:

Indicated thermal efficiency, $e_i = \frac{2545}{Q_i}$

Brake thermal efficiency, $e_b = \frac{2545}{Q_b}$

Combined thermal efficiency, $e_k = \frac{3413}{Q_k}$

Where Q_i = B.t.u. per net i. hp-hr.
Q_b = B.t.u. per b. hp-hr.
Q_k = B.t.u. per net kw-hr.

The thermal efficiency for complete plants will be expressed in the same way, using i.hp., b.hp. net kw., water hp., air hp., etc., as the reference. For example: The overall thermal efficiency of a coal-fired electric plant is

$$\frac{3413}{\text{Calorific value of coal} \times \text{lb. coal per net kw-hr.}}$$

It is to be noted that in present usage the terms "thermal efficiency" and "cycle" are not limited to the thermodynamic sense only. As used in the Code, they are therefore not to be interpreted in the strictly special manner usual in thermodynamics.

Their use in the general sense is established by custom and is perfectly understandable.

The thermal efficiency of a steam engine, steam turbine or internal combustion engine is an overall efficiency which may be separated into two factors: the cycle efficiency and the engine efficiency.

Thermal efficiency = Cycle efficiency × Engine efficiency.

The engine efficiency may, therefore, be found by dividing the thermal efficiency by the cycle efficiency.

Foot (Symbol Ft.).—Measure of length = 12 in.

Gallon U. S. (Symbol gal.).—=231 cu. in. =.134 cu. ft.

Gravity.—Acceleration due to standard (Symbol g) = 980.665 cm/sec^2 = 32.1740 ft/sec^2 which is the actual value of this acceleration at sea level and about 45 deg. latitude. For latitudes between 20 deg. and 70 deg. and altitudes below 5,000 ft., the maximum difference between local and standard gravity is about 1 part in 400, an amount which is ordinarily negligible for engineering purposes.

Heat, Mechanical Equivalent of (Symbol J).—= 778 ft-lb. per B.t.u. For the mechanical equivalent of heat, the following values have been adopted:

J = 778 ft.-lb. = B.t.u.
J = 4.186 Joules per mean gram calorie

Other values which have been used in some of the recent steam tables are: Mollier (1906), 778.28; Marks and Davis (1916), 777.52; Goodenough (1914), 777.64; Callendar (1915), 777.8. The greatest difference of any of these values from 778.00 is about 1 in 1620, an amount which is devoid of physical significance because the uncertainty of the value is at least 1 part in 500. The 15 deg. calorie is known to be about 1 part in 2000, and the mean calorie is known to be nearly the same as the 15 deg. calorie. But the difference between the two is not so accurately known, even its sign being uncertain. In view of this fact it is quite evident that in the value J = 778 ft.-lb. per mean B.t.u., even the 8 is not certain, and that the use of figures beyond the decimal point is a purely illusory refinement. Until standard steam tables are developed, all computations should be made with the value of J upon which the particular steam tables employed are based; otherwise artificial inconsistencies are introduced. The same is true of ammonia and similar tables.

Heat Equivalent of Work (Symbol A).— = 0.001285 B.t.u. per ft.-lb.

Heat Rate.—The heat rate to a steam engine or turbine is the total heat content of the steam entering the engine, plus reheat, less the total heat returnable from engine to boiler per hour per unit of output.

Note.—In case the engine operates on a single Rankine cycle the heat returnable is that heat which is contained in the water at the temperature corresponding to exhaust pressure. For other cycles it is determined by the cycle employed.

The heat rate for a complete steam plant, internal combustion engines and internal combustion plants, is the high calorific value of the fuel multiplied by lbs. of fuel consumed per hour per unit of output.

Horsepower (Symbol hp.).— = 550 ft. lb. per sec. = 33,000 ft. lb. per min. = 1,980,000 ft. lb. per hr. Equivalents: 2,545 B.t.u. per hr.; 745,702 watts; 0.7457 kw.

Horsepower-Hour (Symbol hp. hr.).—Equivalent, 2,545 B.t.u.

Assuming J = 778 ft. lb. per B.t.u.

$$1 \text{ horsepower-hour} = \frac{1{,}980{,}000}{778}$$

= 2544.987 plus B.t.u.

$$1 \text{ kilowatt-hour} = \frac{1{,}980{,}000}{778 \times 0.745702}$$

= 3412.874 plus B.t.u.

Since the value 778 is uncertain by more than one unit, the use of decimal places in the foregoing values is unwarranted and they are abbreviated to 2545 and 3413.

The A.I.E.E. has adopted the value

1 hp. = 746 watts = 550 ft. lb. per sec. (London)
= 550.22 std. ft. lb. per sec.

but inasmuch as the international volt-ampere is now known to be 1.0005 true watts, the above value is not exact, and further, the use of the London ft. lb. in preference to the std. ft. lb. has not been generally adopted. The Bureau of Standards uses 1 U.S. std. hp. = 550 U.S. std. ft. lb. per sec.

Horsepower, Water (Symbol w.hp.).—Water horsepower is to be computed from the equation:

$$\text{Water hp.} = \frac{(\text{lb. of liquid per min.}) \times (\text{total head in ft. of liquid})}{33{,}000}$$

Both suction and discharge heads are to be total heads (inclusive of velocity heads) except in cases where the velocity head is less than 0.2 per cent of the total head. In the latter case static pressure, as usually taken by pressure gauges, may be used without correction for velocity head.

If the total head is given as a difference of pressure the value to be used in the foregoing equation is to be found from the formula:

Head in feet=

$$144 \frac{\text{Pressure difference in lb. per sq. in.}}{\text{Actual density of water in lb. per cu. ft.}}$$

Water horsepower for pumps is a measure of the rate at which energy is supplied to the water or other liquid by the pump. In the case of hydraulic turbines it is a measure of the available energy in the water to be employed by the turbine in unit time.

Ice Point and Steam Point.—The ice point is 32 deg. Fahr. and the steam point 212 deg. Fahr., both at saturation pressures corresponding to these two temperatures, respectively.

Kilowatt (Symbol kw.).— = 1000 watts. Equivalents: 1.3410 hp.; 3413 B.t.u. per hr.; 737.56 ft. lb. per sec.

Kilowatt Hour (Symbol kw. hr.).—Equivalents: 1.3410 hp. hr.; 3413 B.t.u.

Mercury.—The density of mercury at 32 deg. Fahr. is 13.5955 grams per cu. cm. (Kaye & Laby, 1918). The mean cubical expansion between 32 deg. Fahr. and 212 deg. Fahr. is 0.0001014 per deg., and from 32 deg. to 110 deg. Fahr. it is 0.0001010. The factor for reducing inches of mercury to lbs. per sq. in. is 0.4912 at 32 deg. Fahr. For values at other temperatures see Weather Bureau Circular F. or Marks and Davis' Steam Tables.

Pound, Force (Symbol lb.).—A force represented by the weight of one pound mass where gravity has the standard value.

Pound, Foot- (Symbol ft.-lb.).—The work done by 1 lb. force when its point of application moves one foot in the direction of the force.

Pound, Mass (Symbol lb.).—0.4535924 times the mass of the international prototype kilogram.

Pressure, Back.—The back pressure or exhaust pressure for steam engines or turbines is defined as the pressure obtained at or as near as possible to the exhaust flange. For further details, see A.S.M.E. Codes on Instruments and Apparatus, Steam Engines, Steam Turbines and Condensing Apparatus.

Pressure, Initial Steam.—The initial steam pressure for any steam engine or turbine is defined as the average pressure obtained in the supply pipe directly preceding the throttle valve of the engine or turbine. The same definition will apply to any other apparatus using steam and using a stop valve to start or stop it.

Steam Cycle, Rankine.—The Rankine steam cycle consists of

(a) admission at constant pressure and temperature.
(b) adiabatic expansion to the back pressure.
(c) exhaust at constant pressure and temperature.
(d) return to the boiler of the equivalent amount of feedwater, taken at the temperature and pressure of the exhaust steam; there is to be no heat leakage and no friction, so that all stags of the cycle are ideally perfect.

Steam, Quality of.—The quality of steam or other vapor is specified in two ways: If the vapor is superheated, the quality is described by stating the number of degrees of superheat. If the vapor is wet, the quality is described by stating the dryness factor; for example, if steam contains 2½ per cent of moisture, its dryness is 0.975.

Dry steam, to which most steam conditions involving wet steam were formerly corrected, is that condition at which there is present no moisture and no superheat, and the heat content is that of the saturated vapor. It is a condition which cannot be exactly realized commercially, and as the correction to dry steam has never been applied to superheated steam, it appears advisable to discontinue its use. This does not bar its employment, as a condition together with a definite pressure (and back pressure or vacuum) for correcting guarantee tests to a common state.

Steam Rate.—The steam rate of an engine turbine, or complete steam plant is the pounds of steam per hour under actual conditions, per unit of output; it is to be corrected neither for moisture nor superheat. For further details in application, reference should be made to the Individual Test Codes on Reciprocating Steam Engines, Steam Turbines, Reciprocating Steam Pumps and Complete Steam Plants.

Temperature, Absolute (Symbol T).—The absolute temperature in Fahrenheit degrees is denoted by T, and temperature on the ordinary Fahrenheit scale by t, the relation between the two being

$$T = t + 459.6$$

and the absolute temperature of the ice point being T_o = 491.6. The values are uncertain by about two units in the last place given. For all ordinary engineering purposes, such as reduction of gas volumes, the values 460 and 492 are more than sufficiently accurate.

Theoretical Horse Power Required to Raise Water to Different Heights

From the Novo Handbook

HEAD IN FEET

GALLONS PER MINUTE	Ft.	10	15	20	25	30	35	40	45	50	60	75	80	85	90	100
	10	.03	.04	.05	.06	.08	.09	.10	.11	.13	.15	.19	.20	.22	.23	.25
	20	.05	.08	.10	.13	.15	.18	.20	.22	.25	.30	.38	.40	.42	.45	.50
	30	.08	.11	.15	.19	.23	.26	.30	.34	.38	.45	.57	.60	.63	.68	.75
	40	.10	.15	.20	.25	.30	.35	.40	.45	.50	.61	.76	.80	.85	.91	1.01
	50	.13	.19	.25	.32	.38	.44	.50	.57	.63	.76	.95	1.00	1.06	1.14	1.26
	75	.19	.28	.38	.47	.57	.66	.76	.85	.95	1.14	1.42	1.50	1.77	1.70	1.89
	100	.25	.38	.50	.63	.76	.88	1.01	1.14	1.26	1.51	1.89	2.00	2.13	2.27	2.52
	125	.32	.47	.63	.79	.97	1.10	1.26	1.42	1.58	1.89	2.37	2.50	2.66	2.84	3.16
	150	.38	.57	.76	.95	1.14	1.32	1.52	1.70	1.89	2.27	2.84	3.00	3.19	3.41	3.79
	175	.44	.66	.88	1.10	1.32	1.54	1.78	1.99	2.21	2.65	3.31	3.50	3.72	3.98	4.42
	200	.50	.76	1.01	1.26	1.52	1.77	2.02	2.27	2.52	3.03	3.79	4.00	4.25	4.54	5.05
	250	.63	.95	1.26	1.58	1.90	2.20	2.52	2.84	3.16	3.79	4.73	5.00	5.31	5.68	6.31
	300	.76	1.14	1.51	1.90	2.27	2.65	3.03	3.41	3.79	4.54	5.68	6.00	6.37	6.82	7.58
	350	.88	1.33	1.77	2.21	2.65	3.09	3.54	3.98	4.42	5.30	6.62	7.00	7.44	7.95	8.84
	400	1.01	1.52	2.02	2.52	3.03	3.53	4.04	4.55	5.05	6.06	7.57	8.00	8.50	9.09	10.10
	500	1.26	1.90	2.52	3.16	3.78	4.42	5.05	5.69	6.31	7.58	9.47	10.00	10.63	11.36	12.63
	550	1.39	2.08	2.78	3.47	4.17	4.86	5.56	6.26	6.94	8.33	10.42	11.00	11.69	12.50	13.89
	600	1.52	2.28	3.03	3.79	4.55	5.30	6.06	6.82	7.58	9.09	11.36	12.00	12.75	13.64	15.15
	650	1.64	2.47	3.28	4.10	4.93	5.75	6.56	7.39	8.21	9.85	12.31	13.00	13.81	14.77	16.41
	700	1.77	2.66	3.54	5.42	5.30	6.19	7.07	7.96	8.84	10.60	13.26	14.00	14.88	15.91	17.68
	750	1.89	2.85	3.79	4.74	5.68	6.63	7.58	8.53	9.47	11.36	14.20	15.00	15.94	17.04	18.94
	800	2.02	3.04	4.04	5.05	6.06	7.07	8.08	9.10	10.10	12.12	15.15	16.00	17.00	18.18	20.20
	850	2.15	3.23	4.29	5.37	6.44	7.51	8.58	9.67	10.73	12.87	16.10	17.00	18.10	19.32	21.46
	900	2.27	3.42	4.54	5.68	6.82	7.95	9.09	10.24	11.36	13.63	17.04	18.00	19.13	20.45	22.73
	950	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80	11.99	14.39	17.99	19.00	20.20	21.59	23.99
	1000	2.52	3.79	5.05	6.31	7.58	8.84	10.10	11.36	12.63	15.15	18.94	20.00	21.25	22.73	25.25
	2000	5.05	7.57	10.10	12.63	15.15	17.67	20.20	22.72	25.25	30.30	37.87	40.00	42.50	45.45	50.50

Theoretical Horse Power Required to Raise Water to Different Heights

From the Novo Handbook

HEAD IN FEET

GALLONS PER MINUTE	Ft.	150	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
	10	.37	.50	.62	.75	.87	1.00	1.13	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
	20	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
	30	1.12	1.50	1.87	2.25	2.62	3.00	3.38	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00
	40	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
	50	1.87	2.50	3.12	3.75	4.37	5.00	5.63	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00
	75	2.81	3.75	4.69	5.62	6.56	7.50	8.44	9.37	11.25	13.13	15.00	16.88	18.75	20.57	22.50
	100	3.75	5.00	6.75	7.50	8.75	10.00	11.25	12.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00
	125	4.69	6.25	7.81	9.37	10.94	12.50	14.06	15.63	18.75	21.88	25.00	28.13	31.25	34.32	37.50
	150	5.62	7.50	9.37	11.25	13.12	15.00	16.87	18.75	22.50	26.25	30.00	33.75	37.50	41.25	45.00
	175	6.56	8.75	10.94	13.12	15.31	17.50	19.69	21.86	26.25	30.63	35.00	39.37	43.75	48.07	52.50
	200	7.50	10.00	12.50	15.00	17.50	20.00	22.50	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00
	250	9.37	12.50	15.72	18.75	21.87	25.00	28.13	31.50	37.50	43.65	50.00	56.25	63.00	68.75	75.00
	300	11.25	15.00	18.75	22.50	26.25	30.00	33.75	37.50	45.00	53.50	60.00	67.50	75.00	82.50	90.00
	350	13.12	17.50	21.87	26.25	30.62	35.00	39.38	43.75	52.50	61.25	70.00	78.75	87.50	96.25	
	400	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	60.00	70.00	80.00	90.00	100.00		
	500	18.75	25.00	31.25	37.50	43.75	50.00	56.25	62.50	75.00	87.50	100.00				
	550	20.63	27.50	34.38	41.25	48.13	55.00	61.88	68.75	82.50	96.25					
	600	22.50	30.00	37.50	45.00	52.50	60.00	67.50	75.00	90.00						
	650	24.38	32.50	40.63	48.75	56.88	65.00	73.13	81.25	97.50						
	700	26.25	35.00	43.75	52.50	61.26	70.00	78.75	87.50							
	750	28.13	37.50	46.88	56.25	65.63	75.00	84.38	93.75							
	800	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00							
	850	31.85	42.50	53.13	63.75	74.38	85.00	95.63								
	900	33.75	45.00	56.25	67.50	78.75	90.00									
	950	35.63	47.50	59.38	71.25	83.13	95.00									
	1000	37.50	50.00	62.50	75.00	87.50	100.00									
	2000	75.00	100.00													

DAYTON-DOWD COMPANY

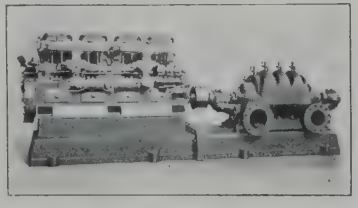
Main Offices and Works: Quincy, Illinois, U. S. A.

Manufacturers of Centrifugal Pumps

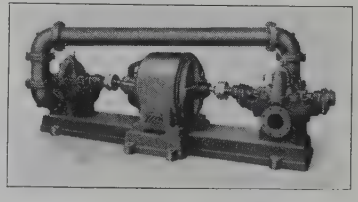
Salt Lake City, 206 South West Temple.
Spokane, Wash., South 118 Lincoln St.
Chicago, 30 North Michigan Blvd.
San Francisco, 7 Front St.
New York City, 369 Lexington Ave.
Washington, D. C., 1816 Park Road, N. Y.
Indianapolis, State Life Bldg.
Milwaukee, 548 Milwaukee St.
Oklahoma City, 301 Local Bldg.
Richmond, Va., Electric Bldg.
Toronto, 610 Federal Bldg.
Edmonton, Can., 10238 104th St.
Cleveland, Ohio, Engineers Bldg.
St. Paul, Minn., 6th and Rosabel Sts.
Omaha, Neb.
Detroit, Mich., 622-4 First St.
Cincinnati, O., Mercantile Library Bldg.
Birmingham, Ala., Moore-Handley Hardware Co.
Baltimore, Md., 120 South Calvert.
Winnipeg, Can., 103 Princess St.
Atlanta, Ga., Hurt Bldg.
Montreal, Can., 1605 Delorimier Ave.
Portland, Ore., 816 Lewis Bldg.
Boston, Mass., 250 Stuart St.
St. Louis, Mo., 2211 Olive St.
Philadelphia, Pa., 1524 Chestnut St.
Vancouver, Can., 609 Credit Foncier Bldg.
Davenport, Iowa, 2108 Grand Ave.
Charlotte, N. C., 101 Kinney Bldg.
Louisville, Ky., 1197 Starks Bldg.
Pittsburgh, Pa., Farmers' Bank Bldg.
Los Angeles, Calif., 722 American Bank Bldg.
Denver, Colo., 618 Exchange Bldg.
New Orleans, La., 1506-7 Masonic Temple.
Houston, Tex., 2d National Bank Bldg.
Memphis, Tenn., 704 Dermon Bldg.
Carthage, N. Y., 616 Alexandria St.
Seattle, Wash., 2726 First Ave., S.
Phoenix, Ariz., Pratt Gilbert Hardware Co.
Duluth, Minn., 316 Glencoe Bldg.
San Benito Texas, P. O. Box 404.
Tulsa, Okla., 211 Commercial Bldg.
Tacoma, Wash., 2123 Pacific Ave.
Butte, Mont., Ben F. Evans.

Products: CENTRIFUGAL PUMPS; SINGLE-STAGE, DOUBLE SUCTION; MULTI-STAGE, AUTOMATICALLY BALANCED TYPE; APPROVED UNDERWRITERS' FIRE PUMPS; OPEN IMPELLER NON-CLOGGING SEWAGE PUMPS, VERTICAL AND HORIZONTAL. Dayton-Dowd Centrifugal pumps embody the most advanced principles of pump engineering in which a fine balance between theory and practice have been established. This, plus the high standards of manufacture, assure the purchaser the utmost satisfaction over a long period of time. **Several Fundamental Points of Pump Design Exemplified in Dayton-Dowd Construction:** First, efficiency of operation. Exact scientific knowledge and the experience of many years are combined in the design of casings and impellers to obtain the highest efficiency possible under various conditions. The water passages are of the correct size and shape to convert most efficiently the velocity into pressure. Second, accessibility. The rotating element of Dayton-Dowd centrifugals may be removed in a few moments by merely lifting the top half casing and bearing caps. The piping is not disturbed. Split glands with swing bolts and plenty of room make packing the boxes an easy matter. Third, interchangeability of parts. Jigs and fixtures are used throughout. All parts are machined to limit gauges and templates. Interchangeability of parts, therefore, is certain. Fourth, strength and long life. Dayton-Dowd pumps are rugged in construction. A generous factor of safety has been allowed which minimizes breakdown and repair bills.

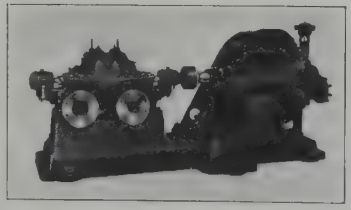
Every Pump Fitted to Individual Needs: The selection of a centrifugal pump involves a careful investigation and consideration of the conditions under which the pump is to operate in order that the pump may be designed with the proper "characteristic curve" to obtain the most economical results. This characteristic or "head volume" curve shows the capacity of the pump at various heads when running at constant speed. Inasmuch as Dayton-Dowd pumps are always designed to fit the particular requirements of each individual order, the most practical relationship between efficiency and head volume is always assured. **Type C S Dayton-Dowd Pumps:** Type C S Pumps are of



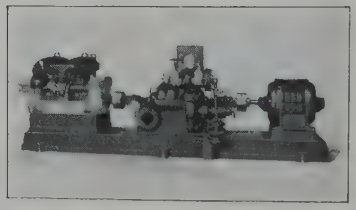
Type CSD Automatically Balanced Multi-Stage Gasoline Engine Driven Pump



Type CS Pumps Connected for Series Operation with Motor Mounted Between Pumps



Type CSD Automatically Balanced Multi-Stage Pump Direct Connected to Steam Turbine



Fire Pump with Dual Drive-Electric Motor and Gasoline Engine for Standby Service

Continued on Next Page

the single stage, double suction types built in sizes from 1½ in. to 48 in. discharge, capacities ranging from 40 gallons per minute to 65,000 gallons per minute. Adapted for any head up to 200 ft. Pumps regularly furnished bronze fitted, but for special service are built of acid resisting bronze or other alloys indicated by the service to be performed. Pumps are of the split-case design; rotor entirely removable without disturbing piping. Impeller design has power-limiting characteristic, protecting motive power from overload in case the head drops off. Ask for Bulletin 267.

Type C S D Multi-Stage Pumps: Are of the automatically balanced type. There are no thrust bearings. Pumps are of split case design; interior of the pump can be inspected by simply removing cover of pump. Built in sizes from 2 in. discharge to 14 in. discharge for capacities from 30 gallons per minute to 7,000 gallons per minute against practically any desired pressure. Adapted for motor, high-speed turbine or other methods of drive. Ask for Bulletin 300.

The C S D F Underwriters' Fire Pumps: Are approved by all Boards of Fire Underwriters. Built in 500, 750, 1,000 and 1,500-gallon-per-minute sizes for motor, steam turbine or gasoline engine drive. Built in accordance with underwriters' specifications. Ask for Bulletin 500.

Bulletins on Dayton-Dowd Centrifugal Pumps:

Type C S and C S L H—General Service Pumps, Bulletin 267.

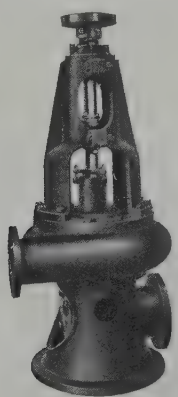
Type C S T Power Limiting Tank Filling and House Pumps, Bulletin 600.

Type S B Belt Driven, Single Suction, General Service Pump, Bulletin 700.

Type C S D Automatically Balanced High Pressure Pumps, Bulletin 300.

Type C S D F Single and Multi-Stage Underwriters' Fire Pump, Bulletin 500.

Type H R Automatic Condensate Return Pumps, Bulletin 900.



Type CV Vertical Non-Clogging Raw Sewage Pump. Has Many Exclusive Features of Design. Impeller and Shaft Entirely Removable Without Disturbing Line Shaft, Pipe Connections or Foundation Alignment

Type S S V Vertical Sump Pumps and Sewage Ejectors, Bulletin 1100.

Type T F Turbine Driven Boilers Feed Units, Bulletin 265.

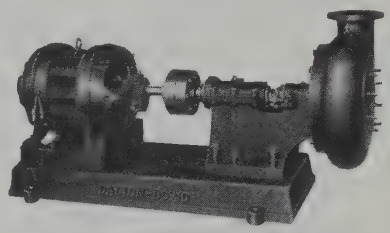
Type N H Motor Driven Brine and Water Pumps, Single Sec., Bulletin 800.

Type C H Non-Clogging Horizontal and Vertical Sewage Pumps, Bulletin 1200.

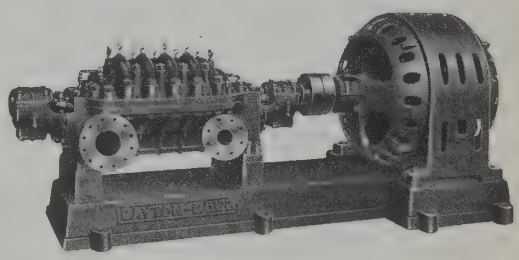
Type S **Paper Stock** Pumps, Bulletin 1300.

Copies of any of these Bulletins will be sent on request.

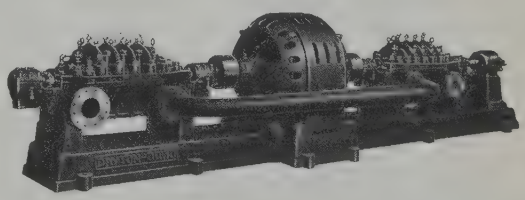
Engineering Service: The experience of our enginering staff is available without obligation in connection with any pumping problems. Special pumps for handling corrosive liquids will be made where indicated. We pour all mixtures of metal, special bronzes, aluminum, lead, cast iron, etc.



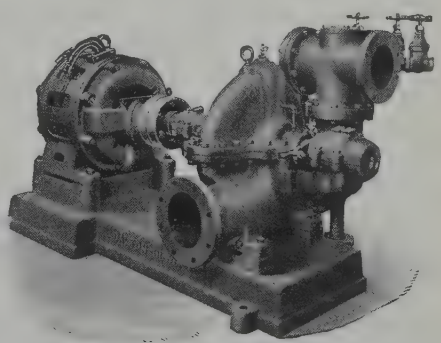
Type CH Horizontal, Non-Clogging Sewage Pump



Type CSDX High Pressure Multi-Stage Automatically Balanced Pump



Type CSDX High Pressure 10-Stage Series Pump. This Unit Designed for 500 GPM, 1,300 Ft. Head



Type CSF Single Stage Motor-Driven Approved Underwriters' Fire Pump Also Built in Multi-Stage Design

MANISTEE IRON WORKS COMPANY

Manistee, Mich.

Manufacturers of Centrifugal Pumps, Rotary Jet Air Pumps, Rotary Jet Condensers

BRANCH OFFICES

Birmingham, Ala.	Chicago, Ill.	Dallas, Tex.	Milwaukee, Wis.	Philadelphia, Pa.	San Francisco, Calif.
Boston, Mass.	Cincinnati, Ohio.	Denver, Colo.	New Orleans, La.	Pittsburgh, Pa.	St. Louis, Mo.
Cedar Rapids, Iowa.	Cleveland, Ohio.	Detroit, Mich.	New York, N. Y.	Salt Lake City, Utah.	St. Paul, Minn.

Products: ROTURBO CENTRIFUGAL PUMPS, ROTARY JET AIR PUMPS, ROTARY JET CONDENSERS.

Also manufacturers of Vacuum Pumps, Fire Protection Pumps, Vacuum Evaporators.

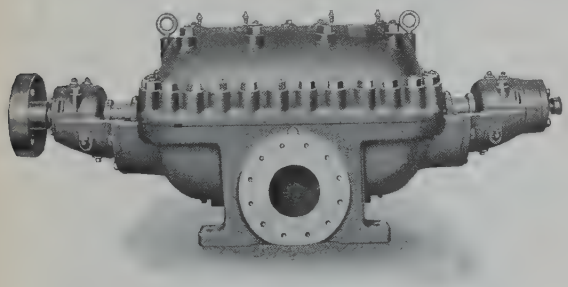
Characteristics of the Manistee Roturbo Pump: The distinguishing feature of the Manistee Roturbo Pump is the construction of the impeller. It differs from the ordinary flat disc runner or impeller.

In the Roturbo impeller the cross section area from the inlet to the outlet is constant. Thus it forms an accumulator for storing water at constant pressures. The cross section area of the common type of impeller gradually diminishes. This results in a gradual acceleration of the velocity of the water. In the Roturbo impeller a large amount of water is subjected to centrifugal force at all times. This generates pressure head directly. The ordinary impeller generates principally velocity energy, leaving it to the diffuser or volute to turn this velocity energy into pressure head. This method is always a very inefficient transformation.

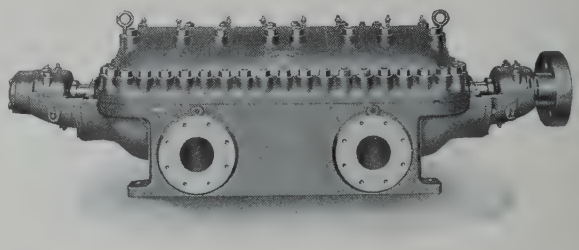
The rim of the Roturbo impeller is arranged with a series of turbine blades curved in an extreme rearward direction relative to the direction of rotation. Due to the water passing through the nozzles formed by these turbine blades, 25 per cent of the pressure energy generated by the impeller is transformed into velocity energy. This velocity energy reacts upon the turbine blades and assists in driving the impeller. In other words, it decreases the power required to drive the impeller. As more water passes through the impeller, due either to an increase in pump speed or a decrease in head, this reaction effect becomes greater. It is possible consequently to operate the pump under any condition of head or volume without overloading the driver. The salient features brought about by this type of impeller are as follows:

1. High Efficiency.
2. Lasting Efficiency.
3. Flat power curve with varying discharge.
4. A flat efficiency curve with varying discharge.

The comparatively high efficiencies obtained by the Manistee Roturbo Pump are due largely to the pressure chamber impeller. On account of the impeller generating the pressure head directly and discharging the liquor with only 25 per cent of its total energy in velocity, the losses in effi-



Four Stage Horizontal Split Roturbo Pump, Type H4



Eight Stage Horizontal Split Roturbo Pump, Type H8

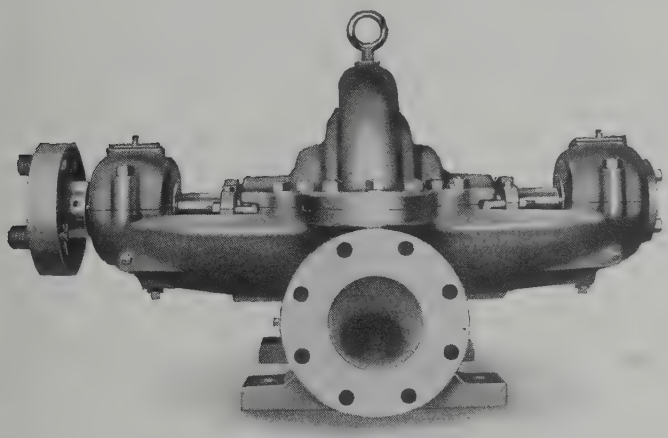
Factory and Main Offices

ciency are very small. As the amount of velocity energy is comparatively small, a very simple form of diffuser can be used. The clearances between the rim of the impeller and the diffuser blades are very large, eliminating the necessity for removable diffuser blade tips.

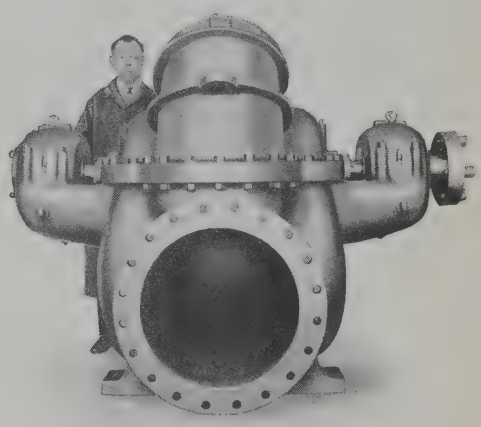
The efficiencies are made more permanent and lasting on account of the extreme low velocity of water through the pump. This causes only a minimum wear on the impellers and diffusers. In the ordinary Centifugal Pump there are considerable losses in efficiency on account of the action of high velocity water on the different metals. It will also be found that there are more stages in a Manistee Roturbo Pump for creating a specified pressure than in the ordinary type of Centrifugal Pump.

The inherent non-overloading type of Roturbo impeller gives to the pump a great deal more useful work energy at the lower heads than the ordinary type. This useful work at lower heads bolsters up and maintains the high efficiency of Roturbo pumps over a wide range. This naturally increases the efficient useful work the pump can perform. In short, at lower heads than specified the Roturbo impeller pump will give more water with the same or less power.

The casing is split horizontally and both branches are cast integral with the lower half casing. Great care is taken in the pouring of metal in the casing in order to secure the exact shape and perfect smoothness necessary for correct water flow.



Volute Type Single Stage Roturbo Centrifugal Pump



Volute Type Single Stage Roturbo Centrifugal Pump

The object of this is to reduce to a minimum the difference in pressures between stages, consequently less losses in efficiency due to leakage.

The characteristic curve of the Roturbo impeller approaches most nearly the ideal head and volume curve for a Centrifugal Pump impeller. This ideal curve is one on which there are no unstable points, so that when operating at a constant speed, there is a different capacity for each condition of head. The highest pressure is obtained when the discharge of the pump is completely shut off. There is a gradual increase in volume as the head is reduced. The curve also shows that at zero head the capacity is 190 per cent of normal.

The brake horsepower curve is of the non-overloading type. At no condition of head or capacity does the power exceed by more than a few per cent the power required to drive the pump at normal capacity. This curve is obtained on account of the extreme rearward direction of discharge of the water, which has a turbine effect on the impeller.

The non-overloading type of power curve can be obtained with the ordinary pump impeller by restricting the area of the inlet water passages. This chokes or limits the amount of water that can pass through the impeller. The result is a head and volume curve which drops off abruptly. Thus when the head is reduced below normal or even as low as zero head, the increase in capacity is very small. This has its effect on the brake horsepower curve which drops off abruptly at the reduced heads.

The Manistee Roturbo Single Stage Pumps are famous for their ruggedness, simplicity and high economy.

Specification for Manistee RoTURBo Horizontally Split Multi-Stage Type Pumps

Casing: The casing will be of the horizontally split type with the suction and discharge openings cast integral with the lower half. The material used will be close grained cast iron or bronze as per detail specifications, accurately machined and free from flaws or other defects.

Hydrostatic Test: Each casing will be given a hydrostatic test of double the pressure of that to which it will be subjected in actual service.

Bearings: The bearings will be of the ring lubricated babbitt type, having very large oil reservoirs.

Diffusers: The stationary diverging channels will be cast iron or bronze, properly machined and made removable and renewable, and fitted with removable and renewable diffuser and eye rings.

Stuffing Boxes: The stuffing boxes will be of ample depth. Metallic packing will be used throughout.

Impeller: Will be of the RoTURBo patent pressure chamber type of cast iron or bronze as per detailed specifications and will be fitted with removable bronze eye rings and bridge rings.

Hydraulic Balance: Impeller will be hydraulically balanced with reference to end and lateral thrust at all speeds.

Shaft: The shaft will be of ample size to transmit the maximum power required without stress or vibration. It will be accurately machined and polished, and provided with bronze sleeves.

Coupling: When pump is arranged for direct connection to prime movers, a flexible coupling will be provided to compensate for slight variation in alignment.

Pulley: When pump is for belt drive, suitable cast iron pulley and outboard bearing will be provided instead of flexible coupling.

Baseplate: The baseplate will be of cast iron, heavy section, suitably ribbed to prevent distortion and extended to receive prime mover or pulley.

Painting: After completion, the interior of the pump will be given one coat of anti-rust paint and the exterior will be suitably covered with dull finish machinery paint. All bright parts will be carefully protected against rusting in transit.

General: The pumps will be well finished throughout and all material will be as per detailed specifications. The workmanship will be first class in all respects.

PEERLESS PUMP COMPANY

Manufacturers of Moturbo Deep-Well Turbine Pumps

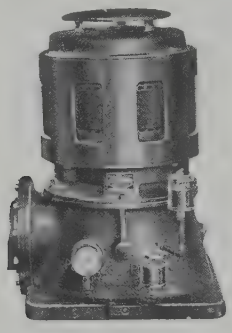
Western Factory, Los Angeles, California, Eastern Factory, Massillon, Ohio

DISTRICT REPRESENTATIVES

Portland, Ore., 355 Everett St.
Yuma, Ariz., 1120 Fifth Ave.
San Francisco, Calif., Room 314, 7 Front St.
Sacramento, Calif., 1327 O St.
San Jose, Calif., 635 South First St.
Fresno, Calif., 1255 Broadway
Bakersfield, Calif., 1514 20th St.
Tulare, Calif., South K and Owens Sts.
Lancaster, Calif.
Amarillo, Tex., 717 Amarillo Bldg.
South America, PO. Box 286, Hanover Square, New York City.
New York, Room 513, 51 E. 42nd St.
Chicago, Room 532, 9 So. Clinton St.
Pittsburgh, Pa., 1601 Arrott Bldg.
Baltimore, Md., 321 Equitable Bldg.
Detroit, Mich., 414-420 Curtis Bldg. 2842 W. Grand Blvd.
Indianapolis, Ind., 945 N. Denny St.
St. Louis, Mo., 923 Chemical Bldg.
Kansas City, Mo., 411 Mutual Bldg.
St. Paul, Minn., 1603 University Ave.
Duluth, Minn., Providence Bldg.
Des Moines, Ia., 207 W. Court Ave.

Products: MOTURBO DEEP WELL TURBINE PUMPS.

Moturbo, with Power Unit Integral: Moturbo is a deep well turbine pump designed for the purpose of lifting water for municipal, industrial and private use. It is a compact, self contained unit with electric auto-controlled driving mechanism integral with the pump head. A simple push button switch controls its operation. It is built in five standard sizes—the power unit ranging from 7½ to 150 H. P.; larger sizes are built upon specifications.



Moturbo

Contrary to the common practice of pump manufacturers of building their product to conform to the driving mechanism, Moturbo is a complete manufactured product. The driving mechanism manufacturers have never built a unit specially for turbine pump operation. This is due to the fact that driving mechanisms are required to cover a wide range of duty. To overcome the compromise in design made necessary by this fact, a special power unit had to be built.

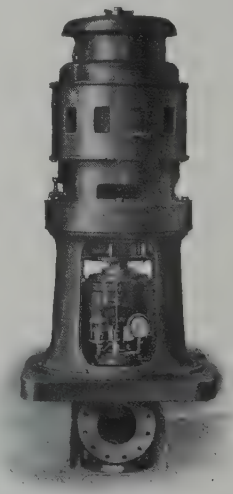
Every part used in Moturbo construction was designed to conform to turbine pump requirements. The complete unit from the intake screen to the cover cap is guaranteed by the Peerless Pump Company.

Cold Oiled—Water Cooled Bearings: All Moturbo bearings are lubricated by cold oil. The oil lubricating the ball thrust and the top ball bearing is kept at an evenly cool temperature by discharging water which surrounds the oil bowl.

The oil is circulated in a steady flow by a spiral rotary pump. It is carried up and through the top bearing and returned downward, through holes provided for this purpose in the casting on the outside of the bearing race, to the oil bowl. The bottom bearing of the pump bowls and shaft line bearings are lubricated from sight feed oil cups by gravity. Cold oil is delivered to these bearings in pre-determined quantities. Moturbo fulfills every requirement of an efficient electrically driven unit and renders obsolete many kinds and designs of deep well turbine pumps.

H. S. D. C.

Peerless Deep Well Turbine Pumps: There are conditions however, that require gas or steam-driven prime movers



B. M. P.

and there are times when the purchaser may desire to use some standard make of motor other than the Auto Control

driving mechanism that forms an integral part of Moturbo construction. To meet such demands, the Peerless Pump Company is manufacturing belt-driven units and heads designed for direct connection to any other standard make of vertical motor. In its sphere this equipment represents as high a standard of development as does Moturbo. Its construction embodies many of the features that helped gain for Moturbo its position in the industrial world. All adjustments of pump runners and shafting can be made without removing the motor or pulley from the pump head. This is a feature rarely found in ordinary units built to accommodate standard vertical motors. In the case of belted-drive units, pulley can be changed without changing adjustment of runners. Peerless units, including Moturbo, combine a range of pumping equipment from which can be obtained the proper unit to fulfill efficiently and economically any pumping requirement.

Underground Discharge: It is convenient under some circumstances to be able to convey the water away from the well-site under the surface of the ground by means of an underground piping system. The two Peerless units that have been designed to this purpose are types B. M. P. and M. U. D. C., one of which is above.

Type M. S. D. C. Full Floating Direct-Connected Head: For direct connection to vertical motors up to, and including, 125 H. P. 6 Pole and 150 H. P. 4 Pole. Ball or plate bearings can be used depending upon the depth of the pump. All bearings are incased in an oil bath which is water cooled.

Pump runners and shaft can be adjusted without disconnecting motor.

Type H. S. B. Full Floating Belted Head: Designed for application up to, and including, 250 H. P. Two extra Heavy Radial Ball Bearings are used to receive belt pull. The thrust load is carried on an extra heavy Segment Plate Bearing operating in water cooled oil.

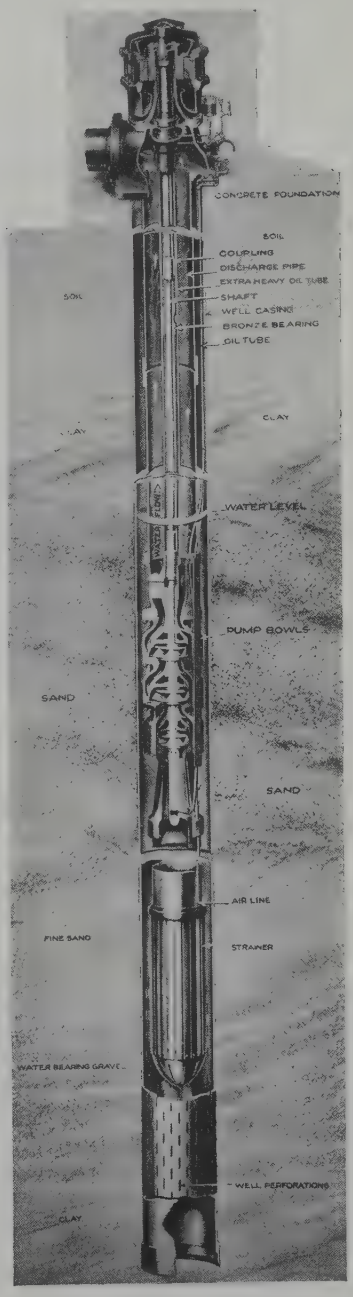
Special installations are available for up to 400 H. P. Belt Drive using four specially mounted Timken Bearings to take belt pull, now in operation on 600 ft. lifts.

Capacities Obtainable

	G.P.M.
For wells 6 in. I. D. or larger	up to 150
For wells 7 in. I. D. or larger	up to 450
For wells 8 in. I. D. or larger	up to 600
For wells 10 in. I. D. or larger	up to 1100
For wells 12 in. I. D. or larger	up to 1500
For wells 14 in. I. D. or larger	up to 2200
For wells 16 in. I. D. or larger	up to 3500
For wells 18 in. I. D. or larger	up to 5000
For wells 20 in. I. D. or larger	up to 6000

Pulley can be changed without changing adjustment of runners. The heavy sub-base insures a rigid foundation.

Type H. S. D. C. Full Floating Direct Connected: For direct connection to any make of standard motor up to 400



H. P. The thrust load is carried on an extra heavy Segment Plate Bearing operating in water-cooled oil.

Pump runners can be adjusted without disconnecting motor.

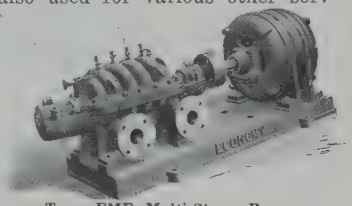
ECONOMY PUMPING MACHINERY CO.

General Office, 3431 West 48th Place, Chicago, Ill.

Double Suction Pump

Economy Pumps

Horizontal Centrifugal Pumps are generally used for water supply, either with overhead tanks or directly into mains as boosters. They are also used for various other services, such as boiler feeding, filter circulation and swimming pool circulation. They are truly general purpose pumps.



Type EMF Multi-Stage Pump

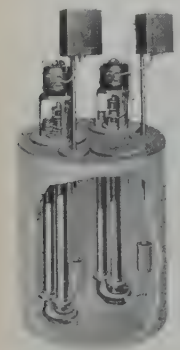
The double suction single stage pumps embody up-to-date hydraulic developments with exceedingly high efficiencies. Their mechanical design is unusually rugged, so that they are fitted for continuous service. Specifications are given in bulletin No. 408.

The high pressure multistage horizontal split case pumps have one piece bronze diaphragm which eliminates leakage between stages. A volute or spiral in every stage results in high pump efficiency without the use of diffusion vanes. The thrust is eliminated with a hydraulic balancing device. See bulletin No. 406 for specifications.

The following table gives only a partial list. Write General Office for detailed information.

Selection Table

Unit No.	Capacity Gallons Per Minute	Total Head in Feet Water	Size Discharge and Type of Pump	Motor Horse Power	Number of Stages	Approximate Floor Space Inches
SC300	150	30	2½"-SM	3	1	20 x 46
SC301	150	60	2½"-SM	5	1	20 x 52
SC302	150	150	2½"-M	10	1	24 x 60
SC303	150	220	2½"-EMF	15	4	24 x 62
SC304	150	300	2½"-EMF	20	6	24 x 70
SC308	150	750	3" -EMF	60	8	34 x 98
SC400	250	30	3" -MF	3	1	22 x 48
SC403	250	80	3" -MF	7½	1	22 x 52
SC408	250	125	2½"-M	15	1	24 x 60
SC409	250	180	3" -H	20	1	30 x 64
SC411	250	375	3" -EMF	40	5	34 x 90
SC412	250	600	3" -EMF	60	7	34 x 98
SC500	500	40	4" -MG	7½	1	26 x 64
SC501	500	80	4" -MG	15	1	26 x 64
SC502	500	150	3" -ME	30	1	34 x 72
SC503	500	200	3" -ME	40	1	34 x 72
SC550	750	40	5" -MH	10	1	26 x 64
SC552	750	110	5" -MH	30	1	26 x 68
SC555	750	200	5" -M	75	1	34 x 84
SC580	1200	30	6" -MJ	15	1	34 x 70
SC581	1200	80	6" -MJ	30	1	34 x 75
SC585	1200	200	5" -M	100	1	34 x 98
SC600	3000	80	8" -M	100	1	42 x 106
SC601	3000	140	8" -M	150	1	48 x 112
SC602	3000	200	8" -M	250	1	56 x 124

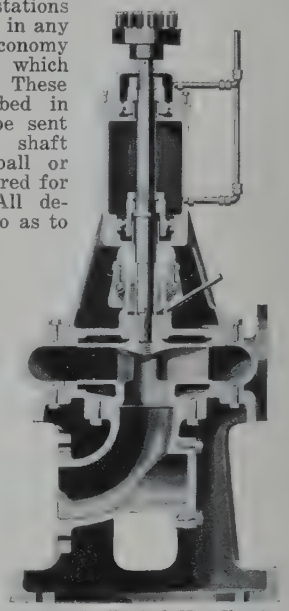


Submerged Type Non-Clogging Pump

Improved Non - Clogging Centrifugal Pumps are made in three designs, all having the same efficient non-clogging impellers but differing in mechanical design. These pumps will handle rags, sticks, etc., which are encountered in unscreened domestic and industrial sewage. The applications of the various types are as follows:

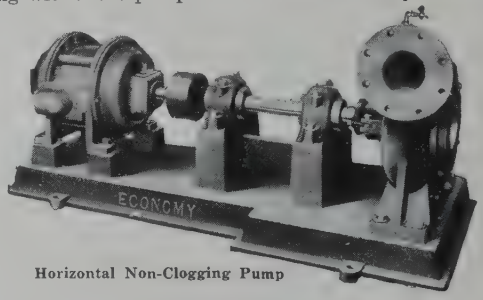
1. Self contained vertical or drop leg type, frequently installed in the smaller isolated plants where the pumps are dropped into the sump and operated submerged without any suction piping, also widely used for draining comfort stations, subways, etc. The patented mechanical design of these pumps adds additional years to their life.

2. The open shaft vertical pumps, generally used in dry pump chamber installations such as are provided in municipal sewage pumping plants, etc. These pumps may be used in concrete or brick pumping stations built in the field or in any of the various Economy steel tank stations which are shipped ready for erection. These pumping stations are described in bulletin No. 411 which will be sent on request. Economy open shaft pumps are built in either ball or sleeve bearing designs as required for the individual application. All designs are pressure lubricated so as to insure continuous service.



Open Shaft Vertical Non-Clogging Pump

3. The horizontal non-clog pumps are used for handling sewage, foodstuffs, paper stock and any other stringy or pulpy material. They are used in sewage disposal plants, garbage reduction plants, or in sewage pumping plants where the pump suction line is above the pump floor level. These pumps may be direct motor driven, belt or chain driven from any suitable power source. They are of unusually rugged design with roller outboard bearings that carry the entire weight of the rotor, there being only a shock bearing within the pump casing.



Horizontal Non-Clogging Pump

The following table gives only a partial list. Write General Office for detailed information.

Selection Table

Capacity G. P. M.		Total Head in Feet					
		15	20	25	30	40	50
150	Size	3-SSV	4-SSV	4-SSV	4-SSV	4-SSV	4-SSV
	H. P.	1½	2	2	3	5	5
	R. P. M.	850	850	850	850	1150	1150
300	Size	4-SSV	4-SSV	4-SSV	4-SSV	4-SSV	4-SSV
	H. P.	2	3	5	5	7½	10
	R. P. M.	850	850	850	850	1150	1150
500	Size	4-SSV	6-SSV	6-SSV	6-SSV	6-SSV	6-SSV
	H. P.	5	5	7½	7½	15	15
	R. P. M.	850	850	850	850	1150	1150
750	Size	6-SSV	6-SSV	6-SSV	6-SSV	6-SSV	6-SSV
	H. P.	7½	7½	10	10	15	20
	R. P. M.	850	850	850	850	1150	1150
1000	Size	6-SSV	6-SSV	8-SSV	8-SSV	8-SSV	8-SSV
	H. P.	7½	10	15	15	20	25
	R. P. M.	850	850	850	850	850	850
1500	Size	8-SSV	8-SSV	8-SSV	8-SSV	8-SSV	10-SSV
	H. P.	10	15	15	20	25	40
	R. P. M.	670	670	670	850	850	850
2000	Size	8-SSV	8-SSV	10-SSV	8-SSV	8-SSV	10-SSV
	H. P.	15	20	25	25	30	50
	R. P. M.	670	670	670	850	850	850
3000	Size	10-SSV	10-SSV	10-SSV	10-SSV	10-SSV	10-SSV
	H. P.	25	30	40	40	50	60
	R. P. M.	670	670	850	850	850	850

FULTON IRON WORKS COMPANY

St. Louis, U. S. A.

Plants and Offices at St. Louis, Mo., and Springfield, Ohio

Successful Engine Builders for Over 75 Years

Manufacturers of DIESEL and Internal Combustion Engines
Gray Iron Castings—1 to 100,000 Lbs.—Rough or Machined

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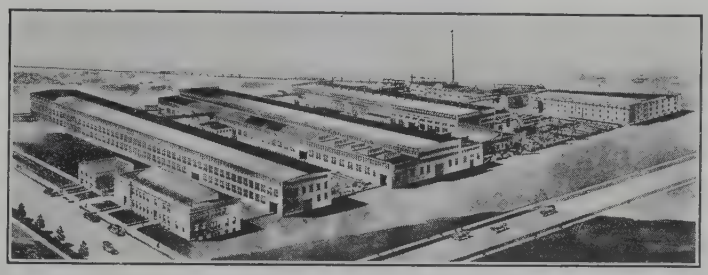
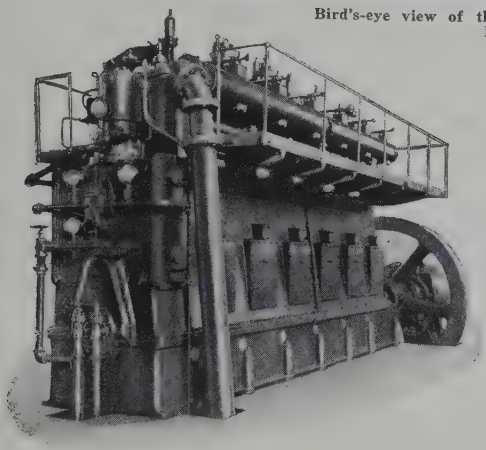
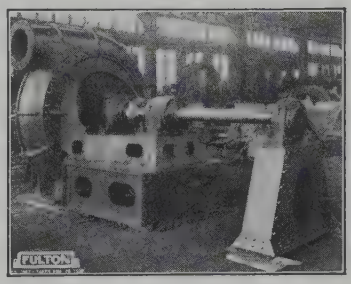
We have completely equipped plant with foundries and machine shops employing 2,000 skilled mechanics, experienced engineers, and designers. Complete organization for financing, designing, manufacturing, and selling. Contract work solicited either to build machinery to your specifications or to develop and improve your rough ideas.



Bird's-eye view of the large, modern St. Louis plant of the Fulton Iron Wks. Co.





Dredge Pump for Great Lake Service

Fulton-Diesel Type BGS Engine: The Type BG Fulton-Diesel is built in 3, 4, 5, 6 and 8 cylinders with ratings of from 375 to 1,000 B. H. P., operating at 225 R. P. M. It is of the air-injection type and is ideal for heavy, continuous duty. This is one of the many Fulton-Diesels that have been giving dependable, economical power service to many towns and cities. Write for complete literature.

Heavy Castings and Special Machinery: Heavy castings of any type manufactured to specifications, either of gray iron or semi-steel, 1 to 100,000 lbs., rough or machined. Our large, modern foundry and machine shops are specially equipped to render prompt and complete service on Manhole Frames and Covers, Fire Hydrants, Lamp Standards, Sluice Gates, etc. Let us quote you on your needs.

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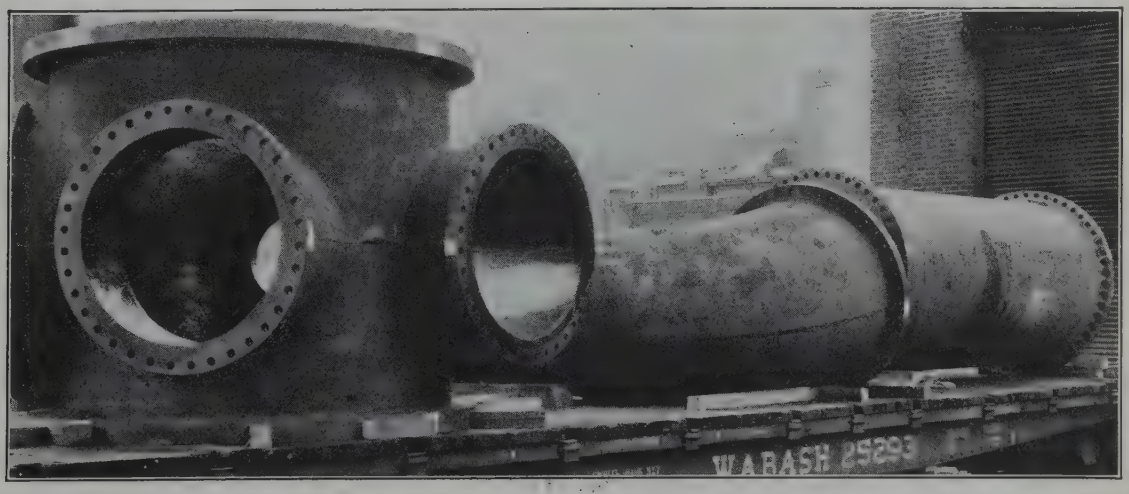


MABBS HYDRAULIC PACKING COMPANY

Incorporated 1892

431 S. Dearborn St., Chicago, Illinois

Manufacturers of Mabbs Rawhide Packing

Sold through supply houses throughout the country

MABBS RAWHIDE PACKING NEVER BECOMES HARD OR GLAZED.

It will never cut or score the metal surfaces.

It is practically antifrictional.

When it is wet, it is as slippery as an eel.

It results in a great saving in power.

It works equally as well on either centrifugal or reciprocating pumps.

Trade Mark

Reg. U. S. Pat. Off.

The Mabbs Rawhide Packing when saturated is too soft to hold the particles of grit upon its surface, but they work back into the body of the Packing. For this reason it can be used to handle very dirty water **without injury** to the shafts and plungers or rods, as is evidenced by the fact that the United States Government has been using this Packing for nearly twenty years on their hydraulic dredges.

When the Mabbs Rawhide Packing is operating on clean liquids it is never necessary to remove the old Packing from the stuffing box; all that is required is to add another ring of Packing occasionally to keep the stuffing box well filled and compensate for wear.

Cases may be cited where brass rods have outworn other parts of the pump when these rods were continuously packed with Mabbs Rawhide Packing.

The Mabbs Rawhide Packing has been installed on brass rods where the stuffing boxes have not been entirely cleaned out in fourteen (14) years, without a mark on the brass rods.

When handling very dirty water, it is a good plan to throw the Packing away occasionally before it becomes completely filled with grit.

After nearly forty years of service in WATERWORKS, it has proven its superiority over any other packing for this purpose.

There is no packing made equal to the Mabbs Rawhide Packing for packing the brass stems of all kinds of water valves and hydraulicly operated valves. If valve stems are packed with this Rawhide Packing continuously, they will operate much freer, and the brass stems will last a life time.

Mabbs Rawhide Packing is particularly desirable for the marine business in such positions as stern tubes, bilge pumps, fire pumps, circulating pumps, sanitary pumps, and brine pumps.

One of the greatest fields where the Mabbs Rawhide Packing has been a pronounced success is the cotton gins in the South where it is almost universally used. This packing is particularly desirable for mining purposes where there is considerable grit and dirt in the water, and also where there may be some acids in the water.

This Packing has proved a great success in the Oil Fields, both on oil pumps and wells.

Mabbs Rawhide Packing is a great success for hydraulic presses of all descriptions. Presses working under a pressure of 10,000 lbs. to the square inch have been successfully packed with Mabbs ¼" Solid Rawhide Packing.

Mabbs Rawhide Packing is very desirable for packing brine pumps handling calcium brine.

The Mabbs Rawhide Packing is made in any size from $\frac{1}{16}$" to 3" running by sixteenths of an inch to ¾", and by eighths of an inch on larger sizes.

Any size of this Packing is put up in standard tin pails of 5-10-25 and 50-lbs., and in kegs and barrels of 100 and 200-lbs. The price of the Mabbs Rawhide Packing is $3.00 per lb.

Rawhide Packing is NOT to be used for either steam or hot liquids.

Mabbs Rawhide Packing weighs only two-thirds as much as flax and when ITS LONG LIFE and ANTI-FRICTIONAL QUALITIES are taken into consideration, you will find it the cheapest packing you can procure.

What users say of Mabbs Rawhide Packing

City of Evanston Filtration Plant,
Evanston, Illinois
J. W. Gaitenby, Supt.,

Since the installation of this plant, we have packed our hydraulically operated valves with flax packing and found it necessary to boost the standpipe pressure from 40 lbs. to 80 lbs. by means of a motor driven booster in order to operate these valves successfully. Since installing your Rawhide Packing, we have been able to discontinue the use of this motor driven booster.

Mason City, Iowa
John C. Stief, Chief Engineer of Water Works

I enclose you in separate package today a sample of your packing which has been in constant use for six years.
The rods are in excellent shape and do not show any wear whatever. This pump has been running 365 days in the year.

Bates Expanded Steel Truss Co.
208 S. LaSalle Street,
Chicago, Illinois
A. J. Bates, Secretary

Relative to the square braided rawhide hydraulic packing of your make that we have in service two 26" cylinders with the pistons packed with your packing. They have been in operation now five years under a water pressure of 500 lbs. per square inch.

We make a specialty of Rawhide Meter Washers which are superior to cork

Recent Developments in Water Purification

In a paper presented Sept. 19, 1928, before the New England Water Works Association Wellington Donaldson of Fuller & McClintock, consulting engineers, New York, gave the following outline of recent changes in established practice in the field of water purification.

Speaking generally, the most notable recent advances have been concerned with processes or modifications of processes rather than with new types of structures. Of the structural changes noted in a survey of the more recent purification plants, the most important are concerned with mechanically-cleaned settling basins, mixing facilities and aeration.

Mechanical Clarifiers.—Originally developed as a metallurgical process, the mechanical clarifier has been finding increased favor in water-works practice. Its first point of entry into water-works practice was in connection with softening plants where the voluminous precipitate produced by lime and soda reactions indicated advantages through continuous removal of sludge, in contrast with the usual practice of intermittently emptying and flushing the settling units. The mechanical clarifier, at first circular in plan with crescentic inlet and outlet troughs, has developed into a square plan having more efficient settling characteristics. The early installations were separate, independent structures. The tendency now is to incorporate the clarifier in one end of a rectangular settling basin, the two structures being integral and with a continuous water surface.

The first mechanical clarifier installation of record in connection with municipal water works was at Benton Harbor, Mich.; put in service in 1923. At the present time the mechanical clarifier has been incorporated in the design of some 14 water-softening plants, chief among which are Newark, Ohio; Piqua, Ohio; Springfield, Ill.; Miami, Fla.; and South Pittsburgh, Pa. The efficiency and economy of these devices, in comparison with the older style settling basins, are not yet fully established, but their popularity would indicate that mechanically-cleaned basins of some type are likely to find a permanent place in connection with water softening.

The utility of the mechanical clarifier for removal of the sludge from softening reactions has more recently been extended into other water-purification fields. At Lancaster, Pa., and Decatur, Ill., clarifiers are used to serve in place of ordinary coagulating basins. The latest adaptation is a preliminary sedimentation device for the very turbid waters of the Middle West. The Missouri River, for instance, has an established peak of 15,000 p.p.m., or 62 tons of dry suspended solids per million gal., while values of 5,000 to 8,000 p.p. m. are not uncommon occurrences during the spring and summer months. The customary practice on the Missouri and other muddy western rivers has been to provide extensive preliminary sedimentation in simple rectangular basins. The large amount of sediment deposited in these basins has necessitated putting them out of service frequently for cleaning purposes, with considerable inconvenience to operation and cost for labor and flushing water. These facts have led to the idea of continuous removal of the deposited sediment in a more satisfactory manner than can be obtained by well-sloped or underdrained bottoms. The result has been an incorporation of mechanical clarifiers in at least two of the important Mid-west plants. The Kansas City, Mo., plant, which went into operation in June of this year, has four 200-ft. diameter, circular clarifiers as preliminary sedimentation units. The new Missouri River plant of the St. Louis water works, now under construction, includes five 150-ft., square clarifiers for preliminary sedimentation ahead of the softening processes. Operating results are not yet available at Kansas City under normal conditions to give a comparison with plain rectangular basins as to efficiency of removing suspended solids and operating costs. Until these points are settled, it is fair to regard the matter as in an experimental state, in so far as these two installations may have a bearing on influencing practice in handling excessively turbid waters. They at least constitute a notable modification over the customary plant layout.

Mixing Facilities.—Another feature of filter plant layouts that has been undergoing extensive modification within recent years, is the mixing arrangement for facilitating the chemical reactions connected with softening or coagulation. The lack of flexibility of the older, baffled type of mixing chamber for varied conditions of flow are well recognize and have led in recent years to experimentation with othe types of mixing devices, though as yet no standard desig has been evolved. The Topeka softening plant has loosely-baffled chamber with mechanical stirrers. Many the recent softening plants employ single circular mixin chambers with mechanical stirrers. The Sacramento, Sa Leandro and Beverly Hills plants employ multiple circul mixers with paddle stirrers, operated in tandem. Knoxvill Tenn., is another recent example. The plants at Providenc R. I., Watertown, N. Y., Albany, N. Y., and Danville, Va have circular mixing tanks without mechanical stirring d vices, the tangential bottom inlets and tangential top outle being relied upon to produce stirring velocities. Th Kansas City and St. Louis works have somewhat simil mixing devices, with the difference that the tangential inl is at the top while the outlet is at the center of the con shaped bottom. The flow is thus downward in a vortex.

Still another notable type is the "hydraulic jump" i stalled in the new 165-m.g.d. Fairmount filter plant at Clev land. The same feature is incorporated in plants at Ba City, Mich., Port Arthur, Tex., Hannibal, Mo., Lake Charle La., and Hamlet, N. C. Most of these newer types of mi ing devices appear to be working satisfactorily, with adva tages over the older types.

Aeration.—Prior to the general adoption of filtratio aeration was regarded as an effective weapon for comba ing odors and tastes in stored waters. Later the mark benefits derived from filtration somewhat obscured the a vantages of aeration, and many representative filter plant built a few years ago, were provided with meager or facilities for aeration. More recently, however, there h been a recrudescence of the aeration idea as water co sumers have become more critical of the physical qualiti of the supply. In several instances aeration of both ra and filtered water is practiced.

Aeration is now employed for other than the original pu pose of overcoming tastes and odors due to plankt growths or the effects of stagnation in stored water. Ce tain classes of trade waste responsible for taste and od respond favorably to aeration, though others do not. West Palm Beach and a few other places, addition of t alum dose prior to passage of the raw water through spr nozzles has been found distinctly helpful in promoting agulation of a soft colored water. At both Richmond, V and Rahway, N. J., it has been found that spray-nozz aeration is quite effective after substantial pre-chlorin tion doses in reducing residual chlorine to within no troublesome limits. Another use for aeration that h come to the front, is its ability to lower the carbon dioxi content, thereby decreasing aggressiveness of the wat This has led to the use of the so-called effluent aerators exemplified by the plants at Albany, Providence, West Pal Beach and Poughkeepsie.

That the aeration feature, aside from its utility, can made to serve an ornamental purpose is shown very well the Kensico and Ashokan installations of the New Yo water supply, and those at Providence, West Palm Bea and the San Leandro plant of Oakland.

In general, where the need of aeration is plainly indicate the tendency has been towards the use of fixed spray nozz in preference to other devices that are not so complete effective. Mention deserves to be made, however, of t floating nozzles in the Sacramento and Beverly Hills i stallations. In the latter, the released hydrogen sulfi gas is captured and discharged through a tall stack avoid complaints in a high-class residence district.

Filters.—No important changes in filter design have co to the front recently. There still exists considerable versity of opinion as to the merits of various styles underdrain systems; none of them are perfect and most them are satisfactory. Of the filter appurtenances such gages, controllers, etc., new designs have appeared with the last year or so, but nothing particularly novel has veloped, excepting the substitution of electrical instrume at Wausau, Wis., for the usual filter flow-gage . It seems be merely a question of healthly competition among manufacturers.

It is worth noting here the revival of the old Hyatt id of washing a filter bed by sections instead of as a whc It will be remembered that some of the early New Yo

Continental filters employed the "quadrant" wash for a single undivided bed, but the idea fell into disuse. It has been revived in a modified form in some of the recent plants for washing beds made up of separate bays; for instance, at Poughkeepsie and West Palm Beach where the four bed sections are washed independently, and at the San Leandro, Calif., plant where the filter is washed by halves. The purpose obviously is to reduce the size of wash piping required and the demand rate of wash water.

Coagulants.—Much experimentation is continually being carried on in various parts of the country to discover coagulants better suited than is ordinary filter alum to certain types of water and to decrease the cost of the preparatory treatment. These experiments have dealt mostly with some form of sodium aluminate under various trade names, usually supplementary to alum. Results reported in some places are distinctly favorable, but in others the trials have shown no advantage either as to efficiency or cost over the customary treatment.

The repertory of water treatment chemicals is continually increasing. From Elizabeth City, N. C., comes a report of the successful use of chlorinated copperas as a coagulant for a soft, highly colored (550 p.p.m.) swamp water after comparison with alum and sodium aluminate as a primary coagulant. The treatment is carried out by simply feeding chlorine to the copperas solution delivered by a dry-feed machine.

Chlorination.—The chlorination of water has expanded considerably. In addition to the common practice of applying the chlorine in a single dose to the plant effluent, many plants are now making use of split treatment, or application at two points. The practice is not uncommon of treating both raw and filtered water where heavy bacterial loading exists. In this case, application to the raw water is usually referred to as "prechlorination." Hackensack, N. J., is a recent convert to this practice, about 0.5 p.p.m. being used as a primary dose to the inlet of the coagulating basins and a second dose of 0.15 p.p.m. being given to the filter-effluent. At Toledo, Ohio, the filtered water is treated twice to secure satisfactory bacterial results. At Richmond, Va., split or double chlorination is practiced in order to keep down algal growths in a shallow, exposed clear-water basin of considerable area. At Kansas City, Kan., a second application of chlorine is used to control algal growths in a distributing reservoir.

Another important use for chlorine is the so-called superchlorination process whereby an unusually large dose is applied for the purpose either of overcoming extraordinary pollution or of destroying obnoxious substances, such as phenols, which the water supply may contain. This method involves a secondary application of sulfur dioxide or other antichlor for reducing the excess chlorine that would otherwise cause taste. It should be pointed out that superchlorination is directed primarily to the destruction of taste- and odor-producing substances that are not removed by the familiar process of coagulation and filtration. In somewhat the same category, but widely different in principle, are the Cleveland experiments for removing taste and odor by filtration through a special activated carbon.

Softening.—The last few years have witnessed notable additions to the list of softened municipal supplies in this country. Advances in this art have been due to the recarbonation feature which not only obviates incrustation, but results also in effective sterilization and enables more complete softening to be carried out than hitherto possible by the lime-soda process, and at less cost. Simpler and more dependable methods of recarbonation have been developed. The pneumatic system of handling lime, as used at Springfield, Ill., gives promise of modifying the older mechanical-conveyor method.

As regards zeolite softening, there are now seven installations in service for municipal water supplies in this country. With the exception of the 4.0-m.g.d. plant of the Ohio Valley Water Co. at McKees Rocks, the installations are all quite small, ranging from 40,000 to 200,000 gal. per day capacity. However, the extreme hardness of the water handled by some of them is notable.

The 2.0-m.g.d. plant at Sewickly, Pa., now nearing completion, is notable for being constructed along lines of ordinary rapid sand filters. In other words, reinforced concrete replaces the steel-shell construction found in the other municipal installations.

Modified methods of washing and regenerating the zeolite filter have come to the front, but in these it is not easy to distinguish between merit and salesmanship. From the published results, however, it appears that the McKees Rocks plant has succeeded in reducing materially the all-important salt ratio. It is interesting to note that a few industrial zeolite installations are reported to be using sea water or oil-well brine for regeneration.

Conclusion.—The matters that have occupied the attention of water-works people lately are not so much new design features as the modified use of purification facilities already available along the lines of coagulation softening and chlorination. The indications are that treatment of water, instead of being simplified, is becoming more complex and more highly specialized. The standards for hygienic safety have for some years been fairly well met. Now there is beginning to come to the front, more prominently than ever before, the expectation that public water supplies will not only be free from danger to health, but also agreeable in physical properties and reasonably low in hardness or other chemical constituents that affect their use not only by domestic consumers but by industries as well. How else can we interpret the refinements now taken for maximum color reduction, for taste and odor control, and the growing demand for softer water!

E. W. BACHARACH & COMPANY

207 Rialto Bldg., Kansas City, Missouri

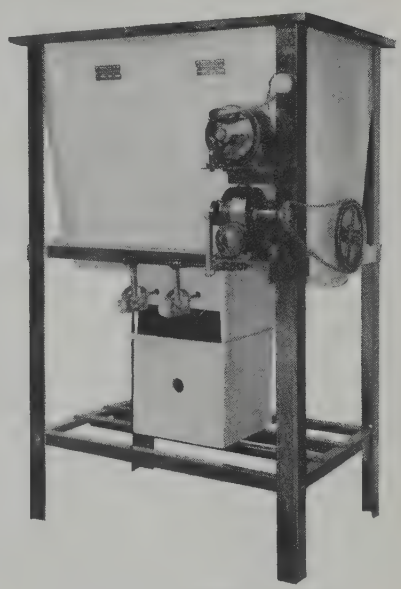
Products: Concrete Gravity Filtration Plant Equipment, Vertical and Horizontal Pressure Filters, Wood Tank Gravity Filters, Iron Removal and Water Softening Plants, Swimming Pool Recirculating-Filtering Systems, Chemical Treating Plant Apparatus.

Kansas City, Mo., 100,000,000 Gal. per day Capacity Filtration Plant

Filtration Plant Equipment: The illustration shows one of the many municipal filtration plants, in which E. W. Bacharach and Company furnished and installed complete equipment consisting of alum manufacturing and treating apparatus, lime slaking and feeding devices, effluent rate controllers, wash water rate controller, operating tables, underdrain systems, filter sand and gravel, chlorinators, venturi meters, loss of head and rate of flow gauges, illuminated dial, and other indicating, recording and integrating gauges, etc.

Chemical Treating Plant Equipment: One of the many types of patented dry chemical feed machines manufactured by E. W. Bacharach and Company is shown in the illustration. It has heretofore been necessary to install a separate dry chemical feeder for each chemical used in a water purification plant. The multiple feed machine involves entirely new principles of operation. This device will accurately feed any number of dry chemicals simultaneously in the same or in different amounts. The machine may also be used to feed several different amounts of the same chemical to separate points of application. The illustration shows a machine built for feeding two chemicals, as for example, lime and alum. The same principle of construction is carried out in building a machine for feeding three or more

Typical Fan-Shaped Swimming Pool



Dry Chemical Feed Machine Multiple Type

chemicals. Some of the advantages of installing a single unit machine that will do the work of a number of individual devices are, reduced initial cost of apparatus, decreased installation expense, saving of space and power, less repairs and depreciation. The multiple machine is built for any capacity and to meet the requirements of any particular installation. It is especially adaptable for use in small and medium sized water purification plants. E. W. Bacharach and Company also build single feed machines and a complete line of chemical solution feed equipment, and will gladly send upon request bulletins, fully describing any kind of water purification plant equipment.

Swimming Pools: Statistics show that in the customary designs of swimming pools, not over 70% of the area is available for persons wishing to stay in the comparatively shallow water, so that the remaining 30% of the pool area is given up to about 10% of the bathers, who dive. The ordinary pool has sharp corners that interfere with circulation so that polluated water is trapped, permitting bacterial growth.

The novel form of fan-shaped pool herewith illustrated is so constructed that the deeper portion is at the narrow end, leaving the greater area for the large majority of persons, who do not dive. All corners are rounded and the shape of the pool is conducive to easy access by life savers. The deep portion is stepped down so that the bottom of the shallow portion need not be constructed at such an acute angle as would be necessary if the declination of the floor was progressively uniform. For any given area, comparatively less material is required in the fan-shaped pool than in one of the forms heretofore used. This unique design is therefore, not only more efficient, but is cheaper to construct. The pool is adaptable for swimming races conforming with the standard regulations of the American Athletic Association. Its odd form blends in with the landscape much better than a rectangular or other conventional design and adds to, rather than detracting from, the beauties of its environment. We have for many years specialized in furnishing and installing complete recirculating filtering and sterilizing equipment for swimming pools. We are prepared to submit plans and specifications for any size of fan-shaped pool to conform with requirements of any State Board of Health or other authority. As we are exclusive licensees to the use of the patent, our customers are protected against any claim of infringement. Further information will be sent upon request, also a list of users of our fan-shaped design of swimming pool and recirculating filtering system.

THE DORR COMPANY, ENGINEERS

Sanitary Engineering Division

247 Park Avenue, New York

Chicago Toronto Denver Joplin Wilkes-Barre Atlanta Los Angeles

Products: THE DORR WATER CLARIFIER, THE DORR MIXER, DORRCO DIAPHRAGM PUMPS.

The Dorr Water Clarifier: The Dorr Clarifier is a mechanical sedimentation unit, designed to effect a continuous collection and removal of the settleable or precipitated solids, in the form of a sludge, from municipal water supplies.

In water softening plants the Clarifier is installed to remove the precipitated solids before filtration of the water. In the water softening plant at Newark, Ohio, for example, the Dorr Clarifier removes about 98 per cent of the total suspended matter present in the water leaving the mixing chambers, the period of detention in the Clarifier being only 22 minutes.

Dorr Traction Clarifier in the Water Treatment Plant at Mamaroneck, N. Y.

The Clarifier is also used on highly colored water to remove the alum floc or other precipitates before the water enters the settling basins.

Where turbid or muddy waters are the source of supply Dorr Clarifiers are used as pre-sedimentation units to remove the bulk of the suspended solids from the water before chemical treatment. Removal of over 90 per cent of the solids before treatment materially reduces the cost of the chemicals for coagulation. The amount of water lost with the sludge is also greatly reduced.

Advantages: Some of the advantages derived from the use of Dorr Clarifiers in water treatment plants are:

Reduced settling volume required as the sludge storage space is eliminated, thus reducing cost of basin construction. Duplicate units—one in use while the other is being cleaned out—are not necessary, as the Clarifier continuously removes the sludge without draining basin.

The continuous discharge of a small quantity of sludge into the river reduces pollution to a minimum. The intermittent cleaning of old types of basins, when sludge discharge is concentrated, discolors streams for many weeks.

The Clarifier facilitates return of sludge to the mixing basins which encourages the formation of larger flocs, thus increasing the settling rate of the solids.

The action of the clarifier raking mechanism produces a denser sludge than can be obtained by plain sedimentation. Basins may be constructed below ground level as periodical emptying by gravity is not required.

The Dorr Mixer: The Dorr Mixer has been especially developed for use in all cases where chemical "dosing" is required. It is particularly applicable for thorough and efficient mixing of lime, soda ash, alum or other chemicals, with water supplies, previous to sedimentation.

Dorr Mixer in the Water Treatment Plant at Boca Raton, Fla.

Dorrco Diaphragm Pumps: Designed to handle thick heavy sludges. Suction type with gravity discharge, pressure type to work against pressure heads up to 40 feet.

Bulletin: Send for "Sanitary Engineering Bulletin" which describes in detail the uses of Dorr Equipment in water treatment plants.

All Dorr Equipment is protected by patents in U. S. and Foreign Countries.

EVERSON FILTER COMPANY

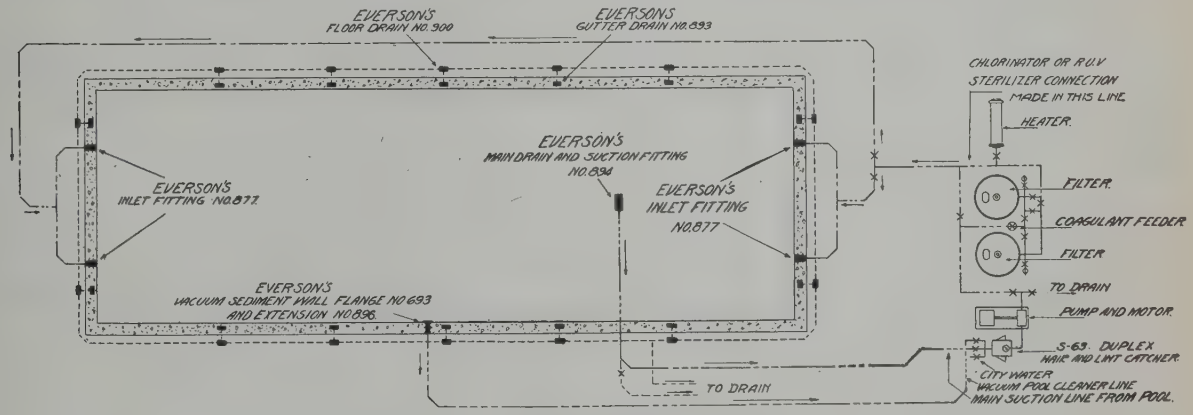
647 N. Green St., Chicago, Ill.

Engineers and Contractors: Swimming Pools, Filtering Systems and Sterlizing Systems

Manufacturers: Filtering Equipment, Water Coolers, Water Softeners, Electric Display Fixtures

Swimming Pools: Designing, engineering and complete construction of all types of swimming pools, including design, manufacture and installation of mechanical equipment for filtration, sterilization and tank cleaning. Contractors for design and manufacture of filtering, purifying and heating equipment only. For over 20 years leading manufacturers of filtering and pool equipment.

Filters for Every Purpose: We manufacture filters, filtering systems and water softening and cooling equipment for public buildings, office buildings, hospitals, hotels—equipment of all sizes, for all purposes. The Everson Eskimo Cooler (a complete drinking fountain unit) is ideal for public places. Everson Zeolite Water Softeners, horizontal or vertical, are exceptionally efficient.


EVERSON'S FLOOR DRAIN NO. 900
EVERSON'S GUTTER DRAIN NO. 893
CHLORINATOR OR R.U.V. STERILIZER CONNECTION MADE IN THIS LINE
HEATER
EVERSON'S MAIN DRAIN AND SUCTION FITTING NO. 894
EVERSON'S INLET FITTING NO. 877
EVERSON'S INLET FITTING NO. 877
FILTER
COAGULANT FEEDER
FILTER
EVERSON'S VACUUM SEDIMENT WALL FLANGE NO. 693 AND EXTENSION NO. 896
TO DRAIN
PUMP AND MOTOR
S-69 DUPLEX HAIR AND LINT CATCHER
CITY WATER
VACUUM POOL CLEANER LINE
MAIN SUCTION LINE FROM POOL
TO DRAIN

Typical Plan of Equipment for 50,000-Gallon Swimming Pool—20x60 Ft.—12-Hour Turnover

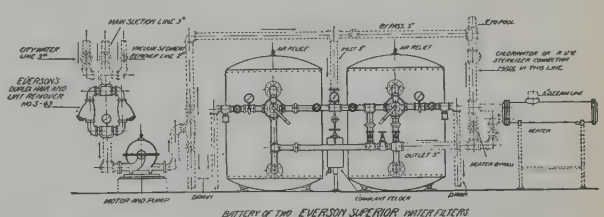
Filtering Equipment for Pools: The Everson Filtering-Clarifying-Purifying System keeps the water crystal clear and pure, free from sediment and germs. A circulating system, operates continuously, minimizes water, water-heating and labor costs. Recommended by health authorities.

Sold completely installed or units (listed below) can be purchased separately.

Filters	Hair and Lint Catchers
Sterilizers	Inlet Fittings
Pumps and Motors	Drain Fittings
Vacuum Tank Cleaners	Gutter Fittings
Water Heaters	Floor Fittings

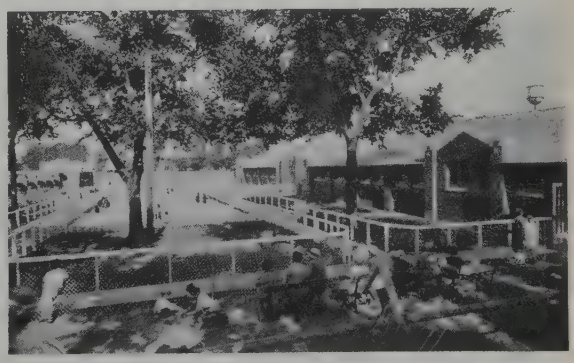
Aerating Nozzles

Estimate Service Free: Drawings, specifications, estimates on any complete pool, pool equipment or filtering system will be gladly furnished without cost or obligation. Bulletins and informative circulars, describing our products and complete installations, sent upon request.


MAIN SUCTION LINE 3"
BY-PASS 3"
CITY WATER LINE 3"
VACUUM SEDIMENT LEADOFF LINE 2"
AIR RELIEF
FILT. 3"
AIR RELIEF
CHLORINATOR OR R.U.V. STERILIZER CONNECTION MADE IN THIS LINE
EVERSON'S DUPLEX HAIR AND LINT RECEIVER NO. S-63
OUTLET 3"
HEATER BYPASS
MOTOR AND PUMP
BATTERY OF TWO EVERSON SUPERIOR WATER FILTERS

Elevation of Mechanical Equipment for Above Pool

Soldiers' Memorial Pool (large pool), Springfield, Ill.



Soldiers' Memorial Pool (small pool), Springfield, Ill.

Miscellaneous Data

Fire Demand

The following tables were abstracted from *Water Works:* The National Board of Fire Underwriters have set forth the following as to requirements to be met for in fire flow:

Table of Required Fire Flow

Population	Required fire flow, gallons per minute, for average city	Population	Required fire flow, gallons per minute, for average city
1,000	1,000	28,000	5,000
2,000	1,500	40,000	6,000
4,000	2,000	60,000	7,000
6,000	2,500	80,000	8,000
10,000	3,000	100,000	9,000
13,000	3,500	125,000	10,000
17,000	4,000	150,000	11,000
22,000	4,500	200,000	12,000

Over 200,000 population 12,000 gal. a minute, with 2,000 to 8,000 additional for a second fire.

Relation Between Domestic and Fire Flows

Population	Required flow for domestic peak G P M	Required flow for fire alone G P M	Size of pipe to deliver Domestic alone, inches	Fire alone, inches	Size of pipe line Total flow, inches
1,000	173	1,000	4	8 or 10	10
2,000	347	1,500	6	10	12
4,000	694	2,000	8	12	14
6,000	1,042	2,500	10	14	16
10,000	1,736	3,000	12	16	18
13,000	2,257	3,500	14	16	18
17,000	2,951	4,000	16	16	20
22,000	3,819	4,500	16	16	24
28,000	4,860	5,000	16	16	24
40,000	6,944	6,000	18	18	30
60,000	10,416	7,000	24	18	30
80,000	13,888	8,000	30	20	36
100,000	17,360	9,000	30	24	42
125,000	21,700	10,000	36	24	42
150,000	26,040	11,000	42	30	48
200,000	34,780	12,000	42 or 48	30	54

Atmospheric Pressure and Barometer Readings

At Different Altitudes, Approximate Values

From "Compressed Air Data," 1924 Edition

Altitude above sea level feet	Atmos. pressure lb. per sq. in.	Barometer reading inches of mercury	Altitude above sea level feet	Atmos. pressure lb. per sq. in.	Barometer reading inches of mercury
0	14.7	30.0	5,500	11.9	24.3
500	14.4	29.4	6,000	11.7	23.8
1,000	14.2	28.9	6,500	11.5	23.4
1,500	13.9	28.3	7,000	11.2	22.9
2,000	13.6	27.8	7,500	11.0	22.5
2,500	13.4	27.2	8,000	10.8	22.1
3,000	13.1	26.7	8,500	10.5	21.7
3,500	12.9	26.2	9,000	10.4	21.2
4,000	12.6	25.7	9,500	10.2	20.8
4,500	12.4	25.2	10,000	10.0	20.4
5,000	12.1	24.8			

Flow of Water at Plumbing Fixtures

Kind of Fixtures	Fair Flow Per Minute gallons	Good Flow Per Minute gallons	Excellent Flow Per Minute gallons
Kitchen Sink Bibbs	2	4	6
Pantry Sink, High Goose Neck Cocks	2	2	3
Pantry Sink, Large Plain Bibbs	4	6	8
Vegetable Sink Bibbs	2	4	6
Laundry Tray Bibbs	4	6	8
Slop Sink Bibbs	3	4	6
Basin Cocks	2	3	4
Bath Cock (either hot or cold)	3	4	6
Shampoo Spray	½	1	2
Liver Spray	1	2	3
Shower Baths, 5-in. Rain Heads	2	3	4
Shower Baths, 6½-in. Rain Heads	2	3	5
Shower Baths, 8-in. Rain Heads	4	6	8
8-in. Tubular Shower Heads	6	8	10
Needle Baths	20	30	40
Manicure Tables	1	1½	2

By "Actual test at 30 lb. pressure." Buenger, Journal American Society of Heating and Ventilating Engineers, November, 1920. (See Cosgrove, Principles and Practice of Plumbing, p. 194.)

Joint Materials Required for Water Pipe

For purposes of estimating, we give the following table, which was taken from *Water Works:*

Size of Pipe, In.	Pounds of Jute Per Joint	Pounds of Lead Per Joint	Size of Pipe, In.	Pounds of Jute Per Joint	Pounds of Lead Per Joint
4	0.2	8	12	0.6	22
6	0.3	12	14	0.8	25
8	0.4	14	16	0.9	34
10	0.5	18	18	1.0	36
			20	1.3	40

Leakage from Various Sized Holes

The following was taken from the *Trade Standards of the Compressed Air Society:* The Rock Island System has posted in conspicuous places in the pumping plants and boiler rooms the sign shown below. This sign carries the size of holes of various diameters and gives the amount of leakage together with the financial loss incurred. Probably nothing impresses the average person as does money, and the column showing the direct money loss should cause many a heretofore unnoticed leak to be repaired.

Size of Opening	Air: No. of cu. ft. wasted per month 100 lb. pressure	Air: Total cost of waste per month at 10 ct. per 1,000 cu. ft.	Steam: No. of lb. wasted per month 100 lb. pressure	Steam: Total cost of waste per month at 60 ct. per 1,000 lb.	Water: No. of gal. wasted per month 40 lb. pressure	Water: Total cost of waste per month at 15½ ct. per 1,000 gal.
⅜	9,979,200	$997.92	460,000	$276.00	692,400	$108.00
¼	4,449,600	444.96	203,000	121.80	307,700	48.00
⅛	1,114,560	111.46	50,500	30.30	76,900	12.00
1/16	278,640	27.86	12,750	7.65	19,200	3.00
1/32	69,552	6.96	3,175	1.91	4,800	0.80

Average Depth of Water Mains in Various Cities

From *Water Works:*

	Average Depth, Ft.		Average Depth, Ft.
[1]Akron, O.	5	Manchester, N. H.	5
Albany, N. Y.	5	Miami, Fla.	3
Annapolis, Md.	4	Mobile, Ala.	2
Atlanta, Ga.	3	Montgomery, Ala.	3
Augusta, Ga.	3	Muskogee, Okla.	3½
[2]Beaumont, Texas	3	Nashville, Tenn.	3
Buffalo, N. Y.	5	[4]Newark, O.	5
Charleston, S. C.	2½	Phoenix, Ariz.	3½
Columbus, O.	3½	Richmond, Va.	4
El Paso, Texas	3	[5]Seattle, Wash.	35 in.
[3]Galveston, Texas	2	Shreveport, La.	3½
Holyoke, Mass.	5	Tampa, Fla.	3
Indianapolis, Ind.	4	Trenton, N. J.	4½
Joliet, Ill.	5	Tulsa, Okla.	3–3½
Knoxville, Tenn.	3	Waco, Texas	2
Los Angeles, Cal.	2½	Wheeling, W. Va.	4½
Louisville, Ky.	4	[6]Wilmington, N. C.	2
Macon, Ga.	3–3½		

[1]5 ft. below established grade, except in cases where it is proposed to leave street below grade for time being when minimum cover may be 3 ft.

[2]3 ft. cover for all mains 10 in. and smaller. 4 ft. to 6 ft. cover for mains 12 in. up to and including 24 in.

[3]All new work 2 ft. depth. Old work varies in depth from 2 ft. to 8 ft. as city was filled and only a part of water pipes were raised.

[4]Trench 5 ft. deep.

[5]6 in. to 8 in., 35 in. below mean curb grades; 10 in., 40 in., 12 in., 43 in.; larger sizes up to 30 in., 36 in.

[6]4 in. cast iron mains, 2 ft. cover; 6 in. and 8 in., 30 in. cover, 12 in., and over 36 in. cover.

Water Mains on Per Capita Basis

The following data were taken from *Water Works:*

A comparison of 12 cities of the United States with respect to the number of feet of water mains on a per capita basis is shown in the following table:

Year	City	Population	Total Feet of Mains	Feet Per Capita	Relative Density of Population
1920	St. Paul	234,000	2,399,000	10.3	1.33
1920	Erie, Pa.	93,000	917,000	9.9	3.70
1920	Springfield, Mass.	129,000	1,249,000	9.7	1.00
1921	Providence	237,000	2,270,000	9.6	4.00
1920	Toledo	243,000	2,261,000	9.3	2.36
1919	Louisville	234,000	2,182,000	9.3	2.75
1920	Columbus	237,000	1,878,000	7.9	3.20
1920	Detroit	994,000	7,222,000	7.3	4.10
1920	Cleveland	797,000	5,478,000	6.9	4.35
1920	St. Louis	773,000	5,350,000	6.9	3.90
1920	Milwaukee	465,000	2,906,000	6.3	5.50
1922	Cambridge	115,000	695,000	6.0	5.10
Totals and Average		4,551,000	34,807,000	7.6	.....

The average density of population of the above 12 cities is 10,700 per square mile and the average number of feet of pipe per square mile is 81,500.

Water Drawn at Fixtures (Estimated)

Fixture	Rate of Flow, Gallons Per Minute	Fixture	Rate of Flow, Gallons Per Minute
Bath	10	Shower	5
Lavatory	5	Sink	10
Tank Closet	5	Laundry Tub	10
Valve Closet	30	Garden Hose	10

Copper and Brass Research Association (Sweet's Catalogue, p. 1457, 17th edition, 1922).

Selection of Filter Sands

Physical and chemical requirements, sources of supply, methods of handling and approximate costs of good filter sand were given by W. M. Weigel, Mineral Technologist, Bureau of Mines, Department of the Interior, Washington, D. C., in *Water Works:*

Most cities of any size that draw their water supply from surface sources use sand filters in their purification system. Not only are sand filters employed to remove sediment and suspended matter, but they also take out most of the bacteria in the water.

The first comprehensive research and study of sand for this purpose was probably that of Hazen for the Massachusetts Board of Health in 1891 and 1892,[1] although sand filters had been employed for a considerable time before. Specifications for filter sand drawn since then have been largely based on the results of Hazen's work.

Requirements.—The general requirements for filter sand are more exacting than for any of the different kinds of sand, except the chemical specifications for glass sand. Filter sand must be uniform in size and within certain limiting sizes. In addition, it must be clean and free from clay and organic matter and of fairly high purity. Early investigations established the fact that an excess of fine material increased the friction and decreased the rate of flow through the filter, and that the size of the finer particles rather than the coarser, determined the effective size. Also, that large grains tended to cause irregularities in flow in different parts of the bed. There is no requirement as to grain shapes, except that they be not flat or elongated, since, so far as known, either rounded or angular grains are equally efficient.

"Effective Size" and "Uniformity Coefficient."—Based on Hazen's investigations, two factors are quite generally used to control the average size and uniformity of size of the sand. These are defined as follows: The "effective size" of a sand is such that 10 per cent by weight of the sand is finer than this size, and 90 per cent is coarser. It is expressed in millimeters. The "uniformity coefficient" is defined as the ratio of the size of grain which has 60 per cent finer than this size to the size which which has 10 per cent finer (the "effective size"). It is evident that the smaller this coefficient, the more uniform is the sand. If all the grains were exactly the same size, the coefficient would be 1.

The ordinary method of determining the effective size and uniformity coefficient, is to make a screen analysis of the dry sand. The cumulative percentages are then plotted against the size of the screen openings. The intersection of the curve with the 90 per cent line gives the effective size, that is, 10 per cent is finer than this. The size corresponding to the 40 per cent value (60 per cent is finer than this), is read from the plot and this divided by the effective size gives the uniformity coefficient. The use of co-ordinate paper, in which percentages are laid off on the vertical axis numerically and the logarithms of the sizes of screen openings along the horizontal, makes a convenient form. Printed blank forms ruled in this way may be obtained from the manufacturers of testing sieves. This method, in reality, represents the size of opening through which the grains will pass, or on which they are retained, rather than the actual grain size. Before accurate screens were obtainable, it was customary to determine the size of grains passing a given screen by collecting the last grains passing and then by counting a known weight of these and, their specific gravity, being known, their diameters assumed as spheres could be calculated.

Specifications usually state, in addition, that no grains shall be larger than a certain mesh and also limit the percentage of every fine material, or that which will pass a 100-mesh sieve, as during the washing with countercurrent flow, the fines collect in the top part of the sand bed and clog the filter.

Sands with effective sizes of 0.20 to 0.70 mm. are used, but those most commonly specified have effective sizes from 0.40 to 0.50 mm. The uniformity coefficient varies from 1.25 to 1.80 with 1.55 to 1.60 as an average.

The following table gives the effective size and uniformity coefficient of samples supplied by some regular producers of filter sand. Tyler standard testing sieves were used in making the analysis.

Sample No.	Source	Effective Size	Uniformity Coefficient
322	New Jersey	0.43	1.40
328	New Jersey	0.38	1.42
329	New Jersey	0.60	1.33
337	New Jersey	0.41	1.39
338	North Carolina	0.38	1.67
345	Illinois	0.42	1.26
348	Minnesota	0.33	1.60
349	Minnesota	0.44	1.52
350	Minnesota	0.37	1.55

Chemical Analysis.—A good filter sand requires a rather high silica content. It is generally specified that not more than 2 per cent shall be soluble in hot dilute hydrochloric acid. Other specifications state that the combined brine and magnesia calculated as carbonates shall not exceed 2 per cent. Aside from this, the chemical composition is usually not specified.

Specifications.—Some condensed specifications are as follows:

Water Department, Baltimore, Md., Filtration Division, Contract No. 22, provides that:

The sand shall be composed of hard and durable grains, either sharp or rounded, substantially free from clay, loam, dust or other foreign matter and flat particles.

When crushed and powdered and digested for 24 hours in strong, warm, hydrochloric acid, without stirring, at least 95 per cent shall remain insoluble. The sand shall not contain more than 2 per cent of calcium and magnesium taken together and calculated as carbonate.

The stock sand furnished shall have an effective size of not less than 0.33 mm. and a uniformity coefficient of about 1.75. At least 90 per cent shall be finer than 2 mm. After being placed and washed (as specified) and the fine sand on top scraped off and removed and the sand rewashed; the top two inches shall have an effective size between 0.40 and 0.50 mm. and not more than 1 per cent shall be finer than 0.25. The diameters of the sand grains shall be computed as the diameters of spheres of equal volumes and all percentages shall be calculated by weight.

The Baltimore Water Department states that, with new work, they would use a little coarser sand, and expect in that way to get better results.

Washington, D. C., specifications provide that:

Sand shall be clean river, beach, or bank sand, either sharp or rounded, entirely free from clay, dust or organic impurities.

Not more than 0.5 per cent shall be less than 0.13 mm; not more than 8 per cent less than 0.26 mm. At least 7 per cent shall be less than 0.34 mm, at least 70 per cent less than 0.83 and at least 90 per cent less than 2.1 mm. No particle shall be less than 5 mm. diameter. The sand shall not contain more than 2 per cent of lime and magnesia calculated as carbonate.

Springfield, Mass., and Toronto, Ont., have general specifications that are the same as those for Washington. Size limits are as follows: The effective size shall not be less than 0.25 mm. nor more than 0.35 mm. The uniformity coefficient shall not be less than 3.0. The sand shall be free from dust and shall not contain more than 1 per cent finer than 0.13 mm. and entirely free from all particles over 5 mm.

A Missouri plant prepares its sand to the following specifications: Effective size not less than 0.40 nor more than 0.50 mm. and uniformity coefficient not greater than 1.65. Not more than 0.25 per cent shall be finer than 0.25 mm. At least 95 per cent shall be finer than 1.2 mm.

Sources of Supply.—Compared with building sand, the production of filter sand is small and requires more careful preparation and extensive plant. A much better price is obtained than for the ordinary grades of sand, and in consequence the points of production are more widely scattered and the sand is sometimes shipped long distances.

The chief producers are in New Jersey, North Carolina, Illinois, Minnesota and Missouri, but any good sand bed can produce suitable filter sand, if it can be washed clean and contains enough grains of the required size to warrant their

[1]Report of the Masschusetts Board of Health, 1892, p. 541.

separation from the rest of the sand. Where the coarser grades of sand-blast sand are produced, the finer material is often prepared for filter sand. Also, the finer grades of sand-blast sand[2] may be used for filter sand if prepared with proper uniformity.

Method of Mining.—Filter sand may be prepared from ocean beaches, lake deposits, river bars, sand banks and soft sandstone, and the method of excavation depends largely on the nature of the deposit.

Where beach sand is used, the excavation is above high tide, so floating dredges are not feasible. Also, the area excavated usually has considerable horizontal extent so that excavating machines are best mounted on railroad track paralleling the direction of the beach. Locomotive cranes with clamshell buckets make about the most efficient equipment; they have a wide reach and are more suited to the comparatively shallow excavations than steam shovels. The sand is conveyed to the washing and screening plant, preferably in side dump cars drawn by steam or gasoline locomotive.

Sand in lake shores and bottoms and river bars is commonly excavated with dredging pumps mounted on barges. They give very mobile, efficient units. Sand can be pumped from any desired part of the bed, and enough water is at the same time pumped for washing or at least most of the washing. The mixture of sand and water is also conveyed to the plant through pipe lines in the same operation, within reasonable distances, and the action of the pump impellers tends to break up any clay lumps and facilitate washing. If the sand is to be conveyed some distance in cars, clamshell dredges sitting on the bank of the lake and loading into cars alongside, are sometimes used, as the power cost is less than for a dredge pump.

When an artificial pond can be maintained, floating dredges are often the most efficient means of excavating the sand from what would otherwise be dry banks. If stripping of overburden is necessary, it is done by hand, scrapers, or steam shovel and the overburden hauled away in wagons or motor trucks. Sometimes, the overburden is back-filled into the excavation. The floating dredges have steam, electric or oil engines, depending on which form of power is cheapest and best suited to the conditions.

Dry sand banks are mined with steam shovels if the plant capacity is sufficient to warrant their use, otherwise the cars or wagons are loaded by hand. Practically all regular producers of filter sand, however, have operations large enough to warrant the use of mechanical excavators.

Soft, friable sandstone constitutes most of the source of filter sand in the Mississippi Valley district. This sand is characterized by uniformly rounded grains, in this way differing from the angular to irregular surfaced grains from lakes and banks. Some river sand also is mined in this territory.[3]

The excavation of sandstone for sand has been briefly described by the writer in Bureau of Mines Serial No. 2615, "Sand Blast Sand."

[2]Weigel, W. M., sand blast sand, Serial 2615, Bureau of Mines, June, 1923.

[3]Dake, C. L. Sand and Gravel Resources of Missouri, No. Bureau of Geol. and Mines, Vol. XVI, 2nd Series, p. 76.

Preparation.—Preparation of filter sand involves washing or screening and usually a combination of both. Very few sands are clean enough without washing. These processes have been outlined in the report on Sand Blast Sand mentioned above, as some firms produce both sand blast and filter sand from the same bed or bank.

For filter sand, the specifications as to size and uniformity is rigid, so that careful screening or sizing is essential. In some instances, the sand is re-screened to insure the removal of fines.

Sizing by screens is almost universal, but where an ample water supply is available, it would seem that hydraulic classification should give a suitable product, as all grain are of the same specific gravity and roughly, of the same shape. It is admitted that more careful supervision would be needed than in sizing by screens, but that should be more than offset by lower first cost or greater capacity, and the washing and sizing would be performed in one operation. The sand originally used for the Washington, D. C., filtration plant was prepared by combined screening and hydraulic classification.[4]

The sand bank used contained considerable clay in the form of lumps and seams that could not be rejected in mining, making removal of the clay necessary. The sand from the bank was first dumped through a coarse grating to remove the larger clay lumps. This was followed by a revolving screen with 2-inch openings. The sand then passed through a revolving screen with 4 mm. openings in which jets of water played. The water and solids passing through this screen flowed to pug mills, which broke up and pulverized the remaining clay lumps. An excess of water here overflowed and removed a good portion of the clay. The sand was drawn out near the bottom. The pug mill was followed by the washers, which were long boxes with sloping bottoms, the feed entering at the shallow end. Water supply pipes near the bottom had perforations pointing downward. The overflow of clay and water was removed by a central trough. The sand, after being separated from the clay by the combined horizontal and upward currents of water, was drawn off at the bottom of the deeper end of the washer. The capacity was stated to be about 1 cubic yard per hour per square foot of box area.

[4]Hazen, Allen, and Hardy, E. D., Water Filtration at Washington, D. C., Trans. Am. Soc. Civil Eng., Vol. LVII, p. 326.

Selected Bibliography of Filter Sand

Filtration of Public Water Supplies, by Allen Hazen, John Wiley & Sons.

Public Water Supplies, by Turneaure and Russell, John Wiley & Sons.

River Sand as Filter Medium, by L. A. Fritze, Jour. American Water Works Association, Vol. 2, p. 390.

The Rapid Filtration Plant at Evanston, Ill., by Langdon Pearse, Jour. American Water Works Association, Vol. 2, p. 172.

Mechanical Analysis of Sands, by Phillip Burgess, Journal American Water Works Association, Vol. 2, p. 493.

Size of Filter Sand at Lima, O., by E. E. Smith, Engineering & Contracting, Vol. 60, p. 102-3.

Importance of Filter Sand and Gravel in Filtration Plants, by A. O. True, Engineering and Contracting, Vol. 59, p. 121.

Analysis of Filter Sands, by Allen Hazen, Report of Massachusetts Board of Health, 1892, p. 541.

Analysis of Filter Sands, by Allen Hazen, Engineering Record, Vol. XXXV, p. 163.

Water Filtration at Washington, by Hazen & Hardy, Trans. Amer. Soc. Civil Engineering, Vol. LVII, p. 326.

Economy Effected in Use of River Sand as Filter Medium at Moline, Ill., Engineering and Contracting, Vol. 43, p. 236.

THE COLUMBIA SILICA COMPANY

Akron, Ohio

Silica Sand and Sand Blast Sand

Chicago Office: A. S. Hindman, 1221 First National Bank Bldg., Chicago, Ill.

Products: Filtering Sand, Silica Sand, Ground Silica, Flint Sand, Blast Sand, Asphalt Sand, Cement Sand, Foundry Sand.

Columbia Sand is an effective filtering medium for filtration plants as has been shown by its use by a number of municipalities. It also is used extensively by filter manufacturers for smaller plants and for swimming pools, industries, public buildings, schools and homes.

Method of Production: The Columbia Silica Company own a 60 acre tract of Silica Deposit, located at Copley, Ohio, a suburb of Akron, Ohio. The deposit is cliff and below surface to a height of approximately 50 feet.

The cliff is first blasted, then a separation is made of the sands and pebbles after which they are run through washers to remove any foreign substances.

Pebbles are run through screens after washed and all moisture is then removed by driers which have a capacity of 50 tons per hour. All material is handled by belt conveyors and elevators.

The smaller mesh of quartz is prepared by crushers and all extreme fines are removed by dust arresters and separated as to mesh into storage bins, seven of which have a capacity of 300 tons each.

Sizes of Gravel are: 1¼ to ¾, ¾ to ⅜, ⅜ to ¼ and ¼ to $\frac{8}{32}$.

The finer mesh is as follows and carry our symbol numbers as shown.

No.	Passing Thru		Retaining On	
1	2½	.120	3½	.092 Wire Screen
2	3½	.092	4½	.072 Wire Screen
3	4½	.072	7	.054 Wire Screen
4	7	.054	10	.035 Wire Screen
5	10	.035	14	.028 Wire Screen
6	14	.028	20	

These grades No. 1 to No. 6 inclusive are angular in form and used extensively in Pressure Filtration.

TEST: Pittsburgh Testing Laboratory of Pittsburgh report material 98.85% Pure Silica Quartz.

A few users of Columbia Pure Silica Quartz:

Swimming Pools, Municipal, Public Schools, Paper Manufacturing Plants, etc.

South Bend, Ind.
Indianapolis, Ind.
Illinois Athletic Club, Chicago, Ill.
Franklin, Ind.
Y. M. C. A., Springfield, Ill.
Broad Ripple Park, Ind.
Ashland, O.
City of Chicago Public Schools (Portion).
Kankakee, Ill.
Canton, O.
Cleveland, O.
Pontiac, Mich., Public Schools.
Mount Hope, W. Va.
Koppers Company.
Commonwealth Edison Co.

Send for samples and quotations.

Worlds Largest Concrete Swimming Pool, Broad Ripple Park, Indianapolis, Ind. Equipped with Perkins Purification System using Columbia Pure Silica Quartz, which changes water daily and assures the public pure drinking water to bathe in.

Graphical Chemistry in Water Softening

The following methods for calculation of analytical values and quantities of chemical reagents used in standard lime and soda ash processes were described by R. L. McNamee, principal assistant engineer, Hoad, Decker, Shoecraft & Drury, consulting engineers, Ann Arbor, Mich., in *Water Works:*

In several years' experience in the study of public water supplies, particularly among the hard ground waters of the region of the Great Lakes, the problem of calculating the measure of hardness and estimating the necessary dosage of softening chemicals has often presented itself. The variety of forms in which water analyses are stated by different analysts involves the problem of calculation. To one not constantly engaged in this work, the recollection or computation of conversion factors is a tedious and sometime uncertain process. In order to simplify these calculations the data have been arranged in the form of nomographic or alignment charts, which are reproduced herewith.

Soap Requirements.—In "The Value of Pure Water," by the late Professor George C. Whipple, there is a very interesting tabulation of the quantities of several commercial brands of soap consumed by various degrees of hardness in water. These data have often served to bring home to the layman one phase of the economic value of water softening to the domestic consumer. A convenient form for these data is given in Fig. 1, an alignment chart in which the intercepts of a straight line on all three scales give related values of the hardness, quantity and brand of soap.

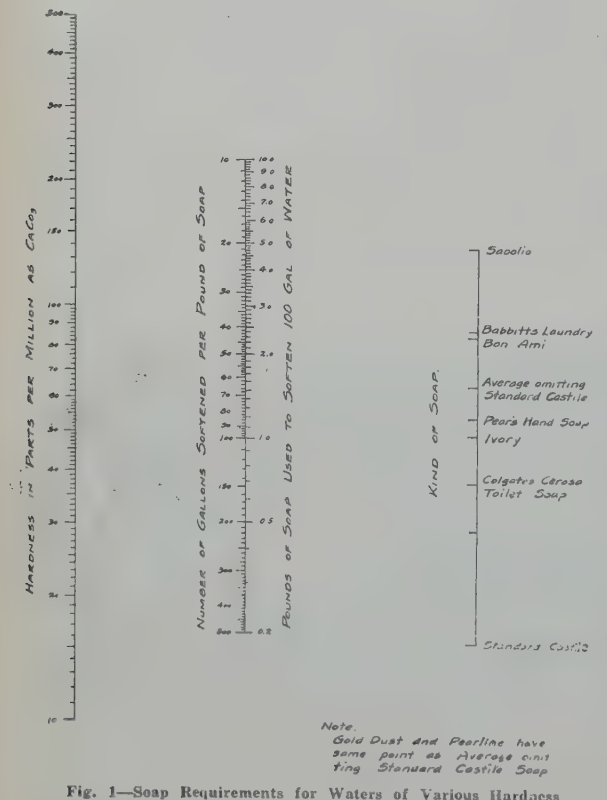

Hardness in Parts per Million as CaCO3
Number of Gallons Softened per Pound of Soap
Pounds of Soap Used to Soften 100 Gal. of Water
Kind of Soap.
Saponio
Babbitts Laundry
Bon Ami
Average omitting Standard Castile
Pears Hand Soap
Ivory
Colgates Cerose Toilet Soap
Standard Castile
Note.
Gold Dust and Pearline have same point as Average omitting Standard Castile Soap

Fig. 1—Soap Requirements for Waters of Various Hardness

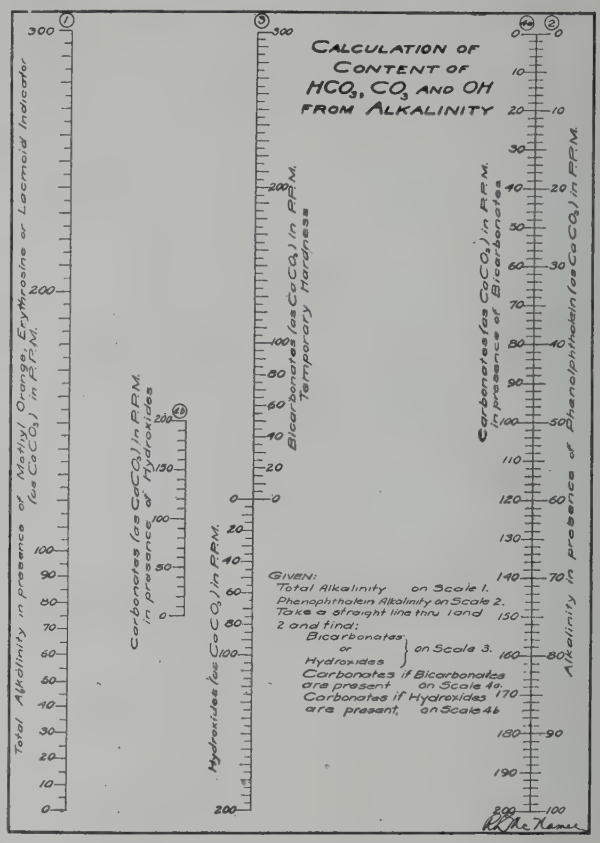

Calculation of Content of HCO3, CO3 and OH from Alkalinity
Total Alkalinity in presence of Methyl Orange, Erythrosine or Lacmoid Indicator (as CaCO3) in P.P.M.
Carbonates (as CaCO3) in P.P.M. in presence of Hydroxides
Hydroxides (as CaCO3) in P.P.M.
Bicarbonates (as CaCO3) in P.P.M. Temporary Hardness
Carbonates (as CaCO3) in P.P.M. in presence of Bicarbonates
Alkalinity in presence of Phenolphthalein (as CaCO3) in P.P.M.
Given:
Total Alkalinity on Scale 1.
Phenolphthalein Alkalinity on Scale 2.
Take a straight line thru 1 and 2 and find:
Bicarbonates or Hydroxides on Scale 3.
Carbonates if Bicarbonates are present on Scale 4a.
Carbonates if Hydroxides are present on Scale 4b

Fig. 2—Calculation of Content of HCO_3, CO_3 and OH from Alkalinity

Determination of Temporary Hardness.—The alkalinity as determined by phenolphthalein and as determined by methyl orange, erythrosine or lacmoid, are often the only reported values given in an analysis which are of any value in estimating the hardness. The fundamental relations between these alkalinity determinations and the corresponding values of the bicarbonate, carbonate and hydroxide radicals are graphically represented in Fig. 2. With only these data given, the temporary hardness alone may be determined.

Calculation of Degree of Hardness.—When the analyses state the values of the calcium, magnesium and bicarbonate radicals, the calculation of the degree of hardness and the required amounts of lime and soda ash necessary for softening is simply a problem of conversion. Fig. 3 is a graphical statement of the relations necessary for the solution of the problem. The calcium (Scale 1), and magnesium present (Scale 2) measure approximately the total hardness (Scale 3). (Iron and certain other radicals are sometimes present and contribute to the hardness, but to such slight extent that they are usually ignored.) The bicarbonate radical (Scale 4) is a measure of the temporary hardness. The difference between the total hardness and the temporary hardness is the permanent hardness (Scale 5), which in turn measures the required amount of soda ash (on the opposite side of the Scale 5). The required amount of lime (Scale 6) is given by the intercept of a straight line connecting the values of magnesium (Scale 2) and bicarbonate (Scale 4).

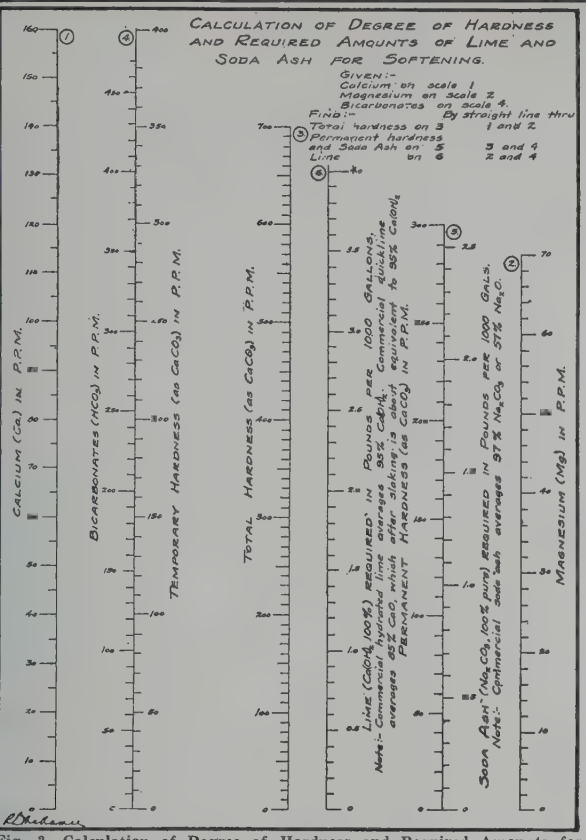

CALCULATION OF DEGREE OF HARDNESS AND REQUIRED AMOUNTS OF LIME AND SODA ASH FOR SOFTENING.
GIVEN:-
Calcium on scale 1
Magnesium on scale 2
Bicarbonates on scale 4.
FIND:-
By straight line thru
Total hardness on 3 1 and 2
Permanent hardness and Soda Ash on 5 3 and 4
Lime on 6 2 and 4
CALCIUM (Ca.) IN P.P.M.
BICARBONATES (HCO3) IN P.P.M.
TEMPORARY HARDNESS (as CaCO3) IN P.P.M.
TOTAL HARDNESS (as CaCO3) IN P.P.M.
LIME (CaO=H2 100%) REQUIRED IN POUNDS PER 1000 GALLONS.
Note:- Commercial hydrated lime averages 95% CaO=H2, Commercial quicklime 85% CaO, which after slaking is equivalent to 95% Ca(OH)2
PERMANENT HARDNESS (as CaCO3) IN P.P.M.
SODA ASH (Na2CO3 100% pure) REQUIRED IN POUNDS PER 1000 GALS.
Note:- Commercial Soda Ash averages 97% Na2CO3 or 57% Na2O.
MAGNESIUM (Mg) IN P.P.M.

Fig. 3—Calculation of Degree of Hardness and Required Amounts for Softening

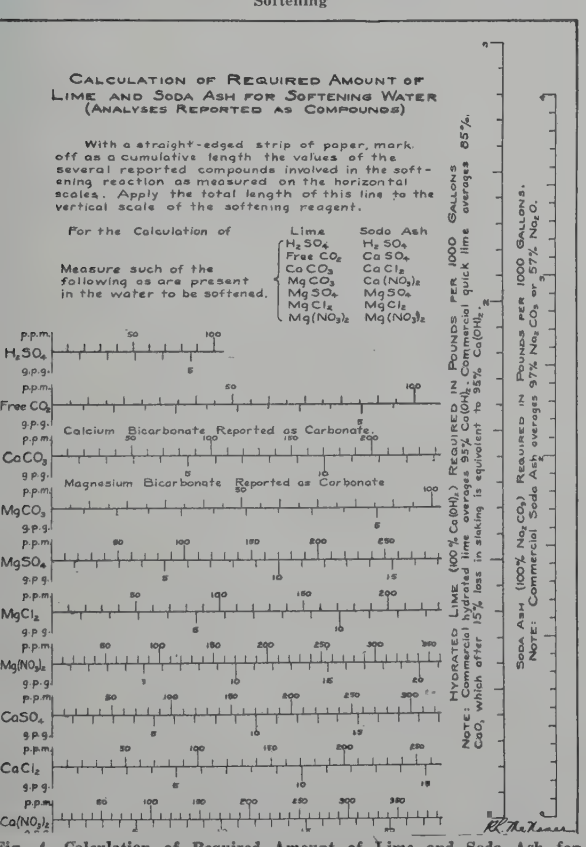

CALCULATION OF REQUIRED AMOUNT OF LIME AND SODA ASH FOR SOFTENING WATER (ANALYSES REPORTED AS COMPOUNDS)
With a straight-edged strip of paper, mark off as a cumulative length the values of the several reported compounds involved in the softening reaction as measured on the horizontal scales. Apply the total length of this line to the vertical scale of the softening reagent.
For the Calculation of
Measure such of the following as are present in the water to be softened.
Lime
H2SO4
Free CO2
CaCO3
MgCO3
MgSO4
MgCl2
Mg(NO3)2
Soda Ash
H2SO4
CaSO4
CaCl2
Ca(NO3)2
MgSO4
MgCl2
Mg(NO3)2
Calcium Bicarbonate Reported as Carbonate
Magnesium Bicarbonate Reported as Carbonate
HYDRATED LIME (100% Ca(OH)2) REQUIRED IN POUNDS PER 1000 GALLONS
Note: Commercial hydrated lime averages 95% Ca(OH)2, Commercial quick lime averages 85% CaO, which after 15% loss in slaking is equivalent to 95% Ca(OH)2
SODA ASH (100% Na2CO3) REQUIRED IN POUNDS PER 1000 GALLONS.
Note: Commercial Soda Ash averages 97% Na2CO3 or 57% Na2O.

Fig. 4—Calculation of Required Amount of Lime and Soda Ash for Softening Water

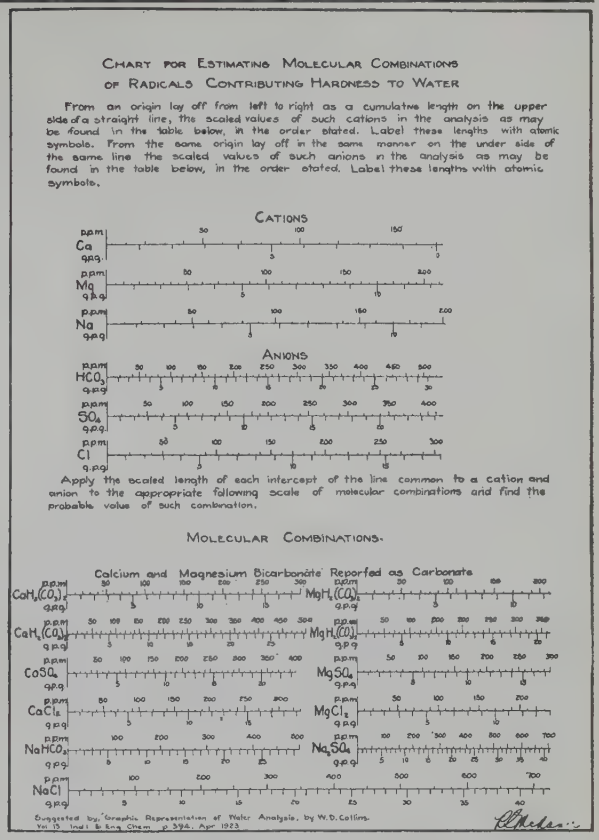


CHART FOR ESTIMATING MOLECULAR COMBINATIONS OF RADICALS CONTRIBUTING HARDNESS TO WATER
From an origin lay off from left to right as a cumulative length on the upper side of a straight line, the scaled values of such cations in the analysis as may be found in the table below, in the order stated. Label these lengths with atomic symbols. From the same origin lay off in the same manner on the under side of the same line the scaled values of such anions in the analysis as may be found in the table below, in the order stated. Label these lengths with atomic symbols.
CATIONS
Ca
Mg
Na
ANIONS
HCO3
SO4
Cl
Apply the scaled length of each intercept of the line common to a cation and anion to the appropriate following scale of molecular combinations and find the probable value of such combination.
MOLECULAR COMBINATIONS.
Calcium and Magnesium Bicarbonate Reported as Carbonate
CaH2(CO3)2
MgH2(CO3)2
CaSO4
MgSO4
CaCl2
MgCl2
NaHCO3
Na2SO4
NaCl
Suggested by "Graphic Representation of Water Analysis," by W. D. Collins. Vol. 15, Ind. & Eng. Chem., p. 396, Apr. 1923.

Fig. 5—Chart for Estimating Molecular Combination of Radicals Contributing Hardness to Water

Lime and Soda Ash Dosage.—When the analyses state values in the molecular form, the calculation of the required amounts of lime and soda ash for softening necessitates the use of molecular weights and equations of reactions, data usually not readily available in the field. Fig. 4 is a yardstick for lime and soda ash dosage. Lengths measured by values of reacting compounds applied cumulatively to the scales of the softening reagents give the quantities required.

In Figs. 3 and 4, the resulting values for lime and soda ash are stated as 100 per cent reagent, and notes are given concerning the strength of commercial chemicals. The investigator should divide the indicated results by the percentage factor for the chemical commercially available for softening.

Estimating Molecular Combinations.—When the analyses state the values in the atomic or radical form, it is frequently desired to know the probable molecular combinations actually present. Mr. W. D. Collins in Volume 15 of "Industrial and Engineering Chemistry" for April, 1923, has suggested a method for approximating these data. Figure 5 is based upon the method suggested by Mr. Collins and carries the computation to a numerical estimate of the molecular values.

The foregoing alignment charts may be found helpful in assisting in the solution of the many problems which are encountered in water analysis and water softening investigations. Their general value will be in relieving the user of the necessity for searching out conversion factors and reacting ratios.

Chlorine in the Fields of Sanitation

PART I

Water Chlorination

The following information was prepared by L. H. Enslow, Research Engineer, Chlorine Institute, Inc.:

The technique of water chlorination at times requires two other gases, sulphur dioxide and ammonia. We cannot at this time foresee the use of oxygen, hydrogen, and acetylene, but as water and sewage problems become more complicated, as they do, anything is possible.

The growth of water chlorination, since its beginning less than 20 years ago, has been phenomenal. Not less than 90,000,000 people in over 6,000 communities are supplied with water rendered safe by chlorine.

Progress in Water Chlorination.—Perfected methods for so-called "free chlorine" determinations by Ellms and Hauser[2] and the subsequent adaptation of the "free chlorine" test in 1918 by Wolman and Enslow[3] provided means of scientific regulation of chlorine dosage. The newer method of control was based on the addition of sufficient chlorine to satisfy the "chlorine demand" and leave some "residual chlorine" in the treated water after a short period of reaction. This proved to be of paramount importance in making chlorination dependable under a great variety of circumstances. Without proper control, chlorination is either overdone or affords only false security. Within the year (1928) failure to regulate the chlorine dosage by making daily tests for residual chlorine resulted in a typhoid epidemic at a small city in New York State. Use of the test would have disclosed the sudden increase of chlorine demand due to the accidental gross pollution of the water supply.

Prechlorination.—One, if not the earliest, to advocate a raw water chlorination to reduce the bacterial load on sand filters and the expenditure for coagulant was N. J. Howard of Toronto,[4,5] where prechlorination has been effectively practiced with a material saving in coagulant for a number of years. It is only within the past two years that prechlorination has received any marked impetus in the United States. This progress is recounted in recent papers by the writer.[1,7]

Aside from the value in reducing the bacteria and rendering additional safety, prechlorination possesses, among others, the following merits:

(a) Allows reduction of residual chlorine carried in finished waters.

(b) Algae growths controlled in basins and filter beds.

(c) Longer filter runs between washings and less wash water required.

(d) Reduction of coagulant dosage in certain instances.

(e) Reduction of "slime" on sand grains and consequent less trouble with mud balls and cracked filter beds. More sparkling effluent results.[12]

(f) Reduced tendency for sludge in coagulation basins to putrefy or lift to the surface as a result of gasification. More palatable water results.

Super- and Dechlorination.—Superchlorination followed by dechlorination was inaugurated at Toronto in the fall of 1926. It was later discontinued, but recurrence of tastes justified resumption of the process in June, 1927, since which time it has continued with success.

The procedure consists of dosing the filtered water with 0.8 to 2.5 parts per million chlorine, the maximum being required in coldest weather. A contact period of approximately one hour is thereafter available in the filtered water collection basin and tunnel delivering to the high pressure pumping station. At this station all excess "residual" chlorine is destroyed by application of sulphur dioxide fed through Wallace and Tiernan "sulfonators" connected to cylinders containing liquefied sulphur dioxide. Excess sulphur dioxide has no deleterious effects, but to insure greatest economy, the plant is operated by simple control tests which indicate that the excess chlorine has been completely destroyed without waste of sulphur dioxide. The superchlorination process is not continuously operated. Laboratory tests on the lake water indicate ahead what to expect in the matter of taste troubles, and only during periods that these tests indicate superchlorination essential is the process used.

The operating cost during use of the process is increased by roughly 78 ct. per million (Imperial) gallons. Normally the cost of ordinary chlorination is 96 ct. per million gallons. Introduction of chlorine in one-ton containers as planned will reduce the chlorine cost to one-half that on which the above figure is based.[1,9]

Other Taste Prevention Measures.—In England, Sir Alexander Houston has again led the way in the field of chlorination by developing and successfully applying the preammoniation and premanganate treatments to prevent taste production in chlorinated waters.[10]

Pre-Ammoniation.—The process consists of application of an ammonia salt or ammonia water sufficient to provide 0.25 ppm. available ammonia (NH_3). In America the ammonia water is prepared at the point of application from anhydrous ammonia. Following the ammonia application chlorine is applied. The supposition is that chloramines are formed which do not subsequently develop taste producing compounds. Regardless of the theories, it seems to be a proven fact that tastes are prevented by preammoniation. In America the process has been employed with success at Greeneville, Tenn., for the past three years.[11] At Springfield, Ill., the process was introduced in February, 1928, and continues to render chlorination non-taste producing.*

Permanganization.—This process consists of application of potassium permanganate ($KMnO_4$) crystals in conjunction with the chlorination. Sir Alexander Houston points out that permanganate may be applied ahead of, immediately at, or beyond the chlorine application with equal efficiency. To certain waters he applies ammonia prior to chlorination continuously and in addition permanganate is at times also applied at the chlorination stations, if there is any evidence of likelihood of taste production. In America the permanganization process is applied either continuously or intermittently at Rochester, N. Y., and Buffalo, N. Y., with success. The point of application is slightly in advance of chlorination. The dosage at Rochester varies between 0.05 (median) to 0.14 (maximum). At Buffalo the dosage has been varied considerably to meet the demand, but an average of 0.03 ppm. is employed for the most part.[1]

Chlorine in Algae Control.—Much of the water supplied Greater New York is chlorinated three times during its travel from its point of origin to the city. As the water is progressively chlorinated during its passage from one

1L. H. Enslow. Recent Developments in Application of Chlorine in Water Purification, Municipal News and Water Works, Aug., 1928; Canadian Engr., Aug. 7 and 14, 1928; Western Water Works (Construction News), Aug., 1928; Jour. A. W. W. A., Nov., 1928.

2J. W. Ellms and S. J. Hauser, Jour. Ind. and Eng. Chem., 5, 11, 915 (Nov., 1913).

3A. Wolman and L. H. Enslow, ibid. 11, 3,209 (Mar., 1919).

4N. J. Howard. Journal A. W. W. A., 9, 4 (1922).

5N. J. Howard. Modified Prechlorination. Canadian Engr., Feb. 26, 1924.

6N. J. Howard and R. E. Thompson, Jour. N. E. W. W. A., No. 3, Sept., 1926; Canadian Engr., Oct. 19, 1926.

7L. H. Enslow. Jour. A. W. W. A., 18, 5 (Nov., 1927); Can. Engr., June 14, 1927; Water Works, July, 1927.

8Martin E. Flentje. Unusual Methods in Water Purification. Excerpts from paper before 1928 meeting, N. E. W. W. A., Water Works Engr., Dec. 5, 1928.

9N. J. Howard. Super-Chlorination of Toronto Water. Can. Engr., June 26, 1928.

10Sir Alexander Houston, 19th, 20th, and 21st, Annual Report, Metropolitan Water Board (London).

11J. W. McAmis. Jour. A. W. W. A., 17, 3, 341 (1927).

12J. S. Whitener. Prechlorination at Raleigh, N. C. Water Works, Dec., 1927, American City, May, 1928.

13Chester Cohen. Jour. A. W. W. A., 16:1:55, July, 1926.

14L. B. Mangum. Algae Control in Reservoir by Chlorination. Munic. News and Water Works, Aug., 1928.

16V. M. Coates, Chlorinating for Prevention of Slimes. The Paper Mill, Nov. 10, 1928.

17L. L. Hedgepeth, Jour. A. W. W. A., 20:4:467 (Oct., 1928).

18F. W. Mohlman and J. R. Palmer, Eng. News Record, Jan. 26, 1928.

21Robert Cramer. Conditions at Sewage Works of Milwaukee. Eng. News-Rec., Nov. 10, 1927. Operation of Milwaukee Sewage Plant. Public Works, Jan., 1928.

22Chas. Krumwiede and W. H. Park, Am. Jour. Pub. Health, Jan., 1928.

23W. F. Wells, Public Health Reports, July 14, 1916.

24F. A. Carmelia, Public Health Reports, April 22, 1921.

25Chas. Krumwiede and W. H. Park. Am. Jour. Pub. Health, Feb., 1926.

26W. F. Wells. Nation's Health, Dec., 1923; Eng. News-Rec., June 14, 1923, p. 1047.

27R. E. Tarbett, Am. Jour. Pub. Health., Jan., 1926.

28W. F. Wells. Chlorination as a Factor of Safety in Shellfish Production. Amer. Jour. Pub. Health, Jan., 1929.

*Through correspondence with Chas. Spaulding, Supt. of Filtration, Springfield, Ill., and L. B. Harrison, Supt. at Bay City, Mich.

reservoir to another, evidence is available to show the material value of the chlorine in reduction of algae growths in these reservoirs, in which previously an increased growth had been observed. In addition to its value in controlling algae growth it has been successfully used to destroy synura, asterionella, tabellaria, anabaena, volvox, melosira, ceratium, aphanizomenon and coelosphaerium in the New York water supply. It seems that 0.5 ppm. residual chlorine will destroy practically all of the objectionable forms of algae and most of them succumb to 0.2 ppm.[1,7,13,14]

Very recently chlorination has been found effective in killing "water fleas" cyclops, daphnia,,[8] all of which are very undesirable in a water supply.

Chlorine in Fungus and "Slime" Control.—Fungi and filamentous slime-like growths such as Leptomitus and Sphaerotitus which occur in sewers and polluted streams are easily killed with chlorine and thereafter slough off and are swept away. In many paper mills biological growths appear in the chests and vats. These growths are known as "slime." Chlorination of the water supply or the "white water" returned to the process is proving very effective in controlling "slime" formation.[16] "Slime" is frequently responsible for an inferior product, or a material loss in production because of temporary shutdown of paper machines, and mill shutdowns for cleanup. Upwards of 40 mills already employ chlorine for "slime" control.

A development along a similar line is the use of chlorine as a preventive of "sliming up" of tubular steam condensers. Chlorine intermittently applied to the cooling water prevents slime deposits on the tube, thus maintaining a higher efficiency of heat transfer and vacuum in the condensers, and a lower operation cost as a result of fewer shutdowns for cleaning and fewer manhours of labor by the cleaning gang.

Chlorine in the Realm of Coagulants.—Ferrous sulphate ($FeSO_2$:$7H_2O$), known as "copperas," has been employed in conjunction with lime as a coagulant for water, sewage and industrial wastes for many years. Mohlman and Palmer[18] suggested and tried the chlorination of a solution of copperas to produce a ferric compound which proved an efficient and economical coagulant for dewatering sludge from the activated sludge process.

Copperas, unless used in conjunction with lime, possesses no value as a coagulant, whereas chlorinated copperas requires no lime, unless the natural alkalinity of the water is extremely low. With organically colored waters, chlorinated copperas is particularly effective. On water containing clay suspension and little or no organic color, it has likewise proven effective.

During 1928 a successful full plant scale demonstration with "chlorinated copperas" has been given. The recent paper[17] by L. L. Hedgepeth, Superintendent of Filtration at Elizabeth City, N. C., gives the detailed account of the process which continues in use at this city with excellent results. One pound of liquid chlorine will oxidize between 7.8 and 8.2 pounds of commercial copperas ($FeSO_4$:$7H_2O$). The use of chlorine in ton container shipments materially reduces the cost of chlorinated copperas and for this reason it may be classified among the lower cost coagulants. The two methods of preparation are given in the papers of Mohlman and Palmer[18] and Hedgepeth[17].

The Oyster and Clam Industry.—Recent studies[22] indicate that oysters contaminated by B. typhosus when in their natural habitat remain infectious for a period of three weeks following contamination. Purification of oysters with chlorine water was first experimentally applied in 1914 by W. F. Wells[23]. The process was more fully developed by Wells and others[24,25] during 1920-1922, but it did not attract much attention, until the typhoid epidemics of 1924 in New York, Chicago, and Baltimore were traced to contaminated oysters. Since 1924, chlorination of oysters has received increased attention and in 1925 and 1926 investigations by the U. S. Public Health Service[27] confirmed the claims made for the process. No harmful effect on taste or appearance of live unshucked oysters was noted. However, it is not recommended that dependence be placed upon chlorination to make oysters from dangerous polluted areas safe. On the other hand, oysters from areas about which there may be some question as to positive safety, at all times may be rendered safe by chlorination.

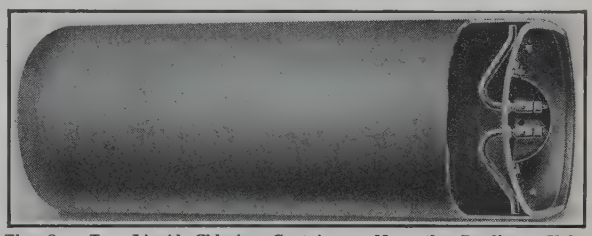
Chlorination of oysters has been likened to pasteurization of milk which enhances the safety of the milk, but does not supplant the care used in the milk plant to keep the milk up to standards of cleanliness. Chlorination of oysters constitutes a highly valuable "factor of safety" by the industry and to the consuming public.

Early in 1925, at West Sayville, L. I., one of the largest oyster packing plants on the Atlantic seaboard adopted the chlorination process and continues to use it. Within the past year or two a number of packers have equipped their plants for chlorination of oysters. The process is described by W. F. Wells[28].

PART II

Advances and Development in Sewage Chlorination

Although sewage chlorination was in reality the forerunner of water chlorination, its growth has lagged until within recent years. The advent of the fifteen and thirty ton liquid chlorine tank cars and more especially the multiple unit car of 15 demountable containers, each of one ton chlorine capacity, has served to awaken renewed interest in sewage chlorination. Chlorine is as a result available at a



The One Ton Liquid Chlorine Container. Note the Duplicate Valve Arrangement and Also That Chlorine Gas May Be Drawn While Container Is Lying Prone or Standing Upright, as Preferred. Container Dimensions: Outside Diameter, 30 In.; Length, 80 In.; Weight, empty, 1300 Lbs.

delivered price approximately one-half that previously paid and thereby the cost of sewage chlorination becomes much more attractive than formerly.

Several new uses for chlorine in sewage treatment have been developed and now chlorination may be considered not alone as a health measure, but also as an adjunct to the several existing methods of sewage disposal. It seems to fill the need often apparent for an inexpensive and simplified process capable of improving objectionable conditions or those which interfere with efficient functioning of sewage plants and sewerage systems.

Disinfection.—In order that efficient disinfection may be continuously and consistently secured, it is essential that sufficient chlorine be applied to insure the presence of 0.2 parts per million or more residual chlorine after a 10 to 15 minute period of contact.[2,3] The total amount of

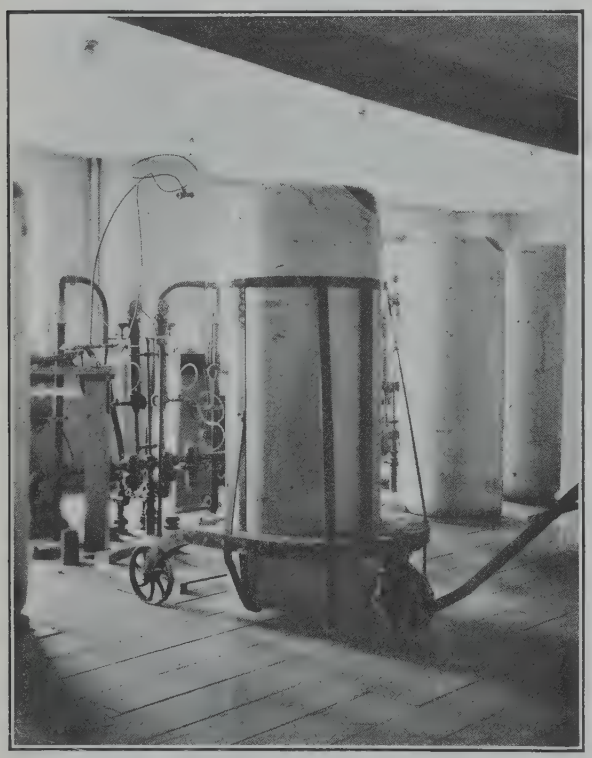
Unloading One Ton Liquid Chlorine Containers (15 to a Car). These Are Transported Singly in One Ton Trucks to the Chlorination Plant

chlorine required is a function of the "chlorine demand" of the sewage or effluent which in turn varies with the quality of the sewage, i. e., whether or not the sewage is concentrated, fresh, stale or actually septic. The weaker and the fresher the sewage the lower will be the chlorine demand. It has been demonstrated that one is warranted in making only rough estimates as to the actual quantity of chlorine required under given conditions. It is paramount that chlorine equipment of adequate capacity to cope with the highest expected demands of the sewage be provided. Thereafter the best results with least expense may be secured by regulation of the chlorine dosage to produce the desired residual chlorine in the sewage.

In the great majority of instances the following minimum and maximum requirements will cover the situation.

Nature of the Sewage	P.p.m. Cl
Crude sewage or settled sewage (fresh to stale)	5 to 15
Crude sewage or settled sewage (septic)	10 to 25
Sprinkling filter effluent (influent to final settling tank)	2 to 5
Activated sludge effluent	1 to 3.5

Prechlorination of the crude sewage possesses many points of advantage when tank treatment and chlorination constitute the only treatment given. Aside from requiring less chlorine on the average the settling chambers serve as contact chambers of long period detention and obviate the necessity and expense incurred in providing additional contact chambers beyond the settling tanks. The tanks serve admirably as "balance wheels" to smooth out fluctuations in the quality and quantity of the sewage flow, and a more uniform result is secured when chlorinating the influent sewage. The chlorine is controlled by testing for residual chlorine at or near the influent end of the settling chambers. Other advantages from prechlorination aside from economy and efficiency of disinfection are discussed later.



One Ton Liquid Chlorine Containers Connected to Chlorinators. Alternate Arrangement Allows Containers to Be Rolled Onto Scale Platform and Gas Fed to Machines From the Prone Position

In case the treatment plant embraces secondary treatment such as trickling filters, chlorine for disinfection and other incidental advantages[4] should be applied at the influent end of the secondary settling tanks, i. e., to the filter effluent rather than to the final effluent. To apply it ahead of the filters would be wasteful practice in instances where disinfection is the chief end sought.

Prechlorination and Split Chlorination.—Attempts to employ the direct feed of chlorine gas to sewage through submerged diffusers have not met with success when the dosage applied exceeds 3 to 3.5 p.p.m. By far the most practical method is that of solution feed wherein the applied chlorine water is mixed with the sewage flow.

At smaller sewage plants it frequently happens that water under pressure is not available. Under such circumstances, the chlorinator may properly be located some distance up the trunk sewer at a point where the muncipal water supply may be available. If there is a crude sewage pump station available within reach of the water mains, the chlorinator should be located at this point. In such cases semi-automatic chlorinators which operate simultaneously with the sewage pumps may be advantageously employed.

If in addition it is considered advisable to chlorinate the effluent at the plant, the major chlorination may be accomplished as above and final effluent chlorination at the plant may be secured with direct feed equipment because of the limited additional chlorine required by the already partially chlorinated effluent. Thus it appears that split chlorination may prove more desirable than single prechlorination in some circumstances.

Disinfection of Fine Screen Sewage.—The investigations of Scott and Poole[3] are the first to produce knowledge as to the expected efficiency of chlorination in conjunction with fine (mechanical) screening of crude sewage. The degree of penetration of the suspended solids was carefully determined as was the value of various periods of contact and residual chlorine concentrations required for contact periods of 15 minutes or less. The data indicates that mechanical screening with chlorination may be depended upon to produce a safe effluent for disposal through ocean outfalls or into major water courses where the chance of nuisance production is remote.

Correction of Odor Nuisances.—Volatile gases are liberated from sewage by aeration in sewers, manholes, a drop over wiers, or more especially from sprinkling filter sprays. The chief offender in this respect is hydrogen sulphide and allied compounds which to most people possess a nauseating odor and serve to accentuate other odors which in themselves might not be objectionable. The presence of hydrogen sulphide gas in sewers is indicated by swelling of mortar joints, softening of concrete and also by blackening of brass, copper or silver. Blotting paper wetted with a saturated lead acetate solution will darken when left exposed in pump sumps or manholes where hydrogen sulphide is present. Any appreciable concentration is thus promptly indicated.

To suppress or arrest hydrogen sulphide production over a desired period of time the crude sewage may be fractionally sterilized to any required degree with chlorine applied at some selected point ahead of the disposal plant. Usually the chlorination should take place at or near the plant proper but there are occasions when chlorination a considerable distance up the trunk sewer is warranted. Such is the case when odors emanate from manholes or where masonry sewers are suffering destruction above the flow line as a result of hydrogen sulphide evolution and subsequent acid production.

Effect of Prechlorination on Plant Performance.—The natural question in the mind of the average reader is, "But what happens to the sludge digestion and the biological filters when the crude sewage is first chlorinated?"

At Portsmouth, Ohio, where prechlorination has been in continuous use for three years, no deleterious effects on sewage solids digestion have been observed. As a matter of fact, the Imhoff tank performance appears to have been improved and scum in the vents is conspicuous by its scarcity.

Investigation by Dr. Willem Rudolfs and W. J. O'Connell of the New Jersey Sewage Experiment Station in connection with prechlorination at the Plainfield, N. J., plant, disclose no harmful effects on subsequent digestion of the solids separating from sewage containing residual chlorine.

Cohn[15] at Schnectady reports that sludge from tanks receiving prechlorinated sewage appeared to be superior to that from parallel tanks receiving unchlorinated sewage. Fair and Carlson[16] at Harvard University conducted two distinct series of tests in which solids from the same sewage—one portion having been heavily chlorinated and the

other not chlorinated—were compared for rates and thoroughness of digestion. The rate of digestion as indicated by methane gas (CH_4) production indicated a more rapid digestion of the solids from the chlorinated sewages than was observed for the unchlorinated. At Bath, England, prechlorination has not proven deleterious to sludge digestion and at Baltimore, Md., additional investigations along this line on a small plant scale are now under way.

At Lufkin[17] and Breckenridge, Tex.[18] foaming of Imhoff tanks was alleviated following introduction of prechlorination. F. C. Dugan of the Kentucky State Board of Health reports a similar experience at a small plant. On the other hand, there have been two instances wherein prechlorination was not effective in controlling foaming of tanks.

At Schenectady, N. Y.[15] and Canton, Ohio, prechlorination produced flocculation of some of the nonsettleable matter in the flow chambers.

At Canton, Ohio, very soon after beginning prechlorination, the sprinkling filter effluent improved in quality and biochemical oxygen demand value. The filters unloaded their organic accumulations and the surface algae growths were killed and washed out.

At Singapore, Straights Settlement,[19] chlorination was employed to clean up the badly ponded trickling filters. Following this the filters improved in efficiency and the improvement in quality of effluent was marked. At Schenectady[15] the nitrification through the filters increased following drastic chlorination to free the stone of heavy film growths. At Bath, England, the oxidation by the filters has apparently been somewhat greater as a result of prechlorination of the crude sewage to retard septic action in a 5-mile main.

At Lackawanna, N. Y.,[32] a serious case of filter ponding as a result of algae and light solids discharging from the Imhoff tanks was reducing the plant efficiency. Clorination of the tank effluent to the filters relieved this condition. This was a representative case of pronounced filter ponding and the value of chlorine as a remedy for such difficulties was demonstrated beyond all expectations.

Effect of Chlorine on Putrescible Matters in Sewage.—The putrescible matters in sewage effluents are measured by determining the demand exerted by the sewage for dissolved oxygen. This oxygen absorption is spoken of as the biochemical oxygen demand. This demand varies with the organic content, the nature of the organic matter present and the period of contact of the sewage with the cleaner water containing the dissolved oxygen. Killing of fish, odor nuisance, and the foul appearance of the streams receiving sewage are all matters which may be avoided by reduction of the oxygen demand of the sewage to a point at which it will not deplete the oxygen in the receiving stream.

Biological beds such as sprinkling filters and oxidation processes such as the activated sludge process effect marked reductions in the oxygen demand of sewage. Simple settling out of the solids from crude sewage results in reductions of from 30 to 40 per cent of the oxygen requirement of the crude sewage.

Chlorine is a powerful oxidizing agent but aside from this property there appears to be an additional effect secured from chlorination which reduces the oxygen demand of sewage and can only be explained by assuming that some of the organic matter in true solution or in the colloidal state is chemically changed by chlorination with chlorine. In so changing the composition of the food supply of the bacteria or other biological forms always present in the receiving stream there is less oxygen demand exerted by the chlorinated sewage. This because some of the putrescible matter has been rendered non-putrescible or less putrescible even in the presence of great numbers of bacteria.

Chlorination does not reduce the oxygen demand of settled sewages to anything like that secured by efficient sprinkling filters but this could hardly be expected. As a rule settling tanks followed by sprinkling filters will reduce the five-day oxygen demand of the crude sewage by roughly 80 to 85 per cent. Chlorination will usually reduce the demand of a settled effluent somewhere between 25 and 35 per cent and thus an overall reduction of the five-day demand for the tanks plus chlorination somewhere between 55 and 65 per cent is secured provided the settling tanks are fairly efficient and bring about a reduction of approximately 40 per cent in the demand without chlorination.

Under certain conditions when more than tank treatment is indicated, but where the extent of oxidation by biological processes does not seem requisite, then tank treatment in conjunction with chlorination may serve to fill the existing gap now found between the purification available from settling tanks alone and that high degree of oxidation afforded by the expensive biological processes. In certain instances tank treatment may suffice for the periods of the year when stream flow is adequate whereas with less water in the streams chlorination as an adjunct to tank treatment may prove very much worth while.

Notable reductions in the organic nitrogen content of sewage effluents at Bedford and Mt. Kisco, New York, plants have resulted from chlorination.[20]

The first work done in respect to the effect of chlorine to reduce biochemical oxygen demands of settled sewage was Dallas, Texas, by cooperative arrangement between the Texas State Health Department, the City of Dallas, and The Chlorine Institute, Inc., early in 1926. The unpublished results showed positive reductions which varied in extent with the strength of the sewage. Since this work there have been several investigations, made along the same line, by Morton at Harvard University,[21] Cohn at Schenectady,[15] Tiedeman at Huntington, L. I.,[2] Ellms at Cleveland, Ohio, McGuire at Columbus, Ohio,[22] Baity at Chapel Hill, N. C.,[23] Reinke at Tulare, Calif., O'Connell at New Brunswick, N. J., Carpenter at New York (Jamaica plant), and Mohlman and Hurwitz at Chicago.[33] Much of this work has not yet been published, but the results are interesting in that they confirm the earlier work.

At Cleveland, Ohio, results are available for the years 1927 and 1928 which show reductions as follows:

Cleveland, Ohio

Year	Sewage Chlorinated	P.p.m. Avg. Chlorine	5-Day BOD Reduction P.p.m.	Per Cent
1927	Screened	7.27*	23	17.5
1927	Settled	9.72*	26	26.0
1928	Screened	8.55*	20	14.5
1928	Settled	9.85*	25	23.0

*Chlorine dosage not sufficient to produce residual chlorine in samples examined.

Effect of Chlorine on Slime Like Growths in Sewers and Streams.—The application of chlorine or hypochlorite of lime (bleach) has resulted in ridding sewers of the slime like growths that sometimes produce trouble. This effect was pronounced at Canton, Ohio, Plainfield, N. J., and Porterville, Calif.

Small streams containing heavy filamentous growths have been cleared up by chlorine application to the sewage effluent.

At Leipsig, Germany, chlorination of settled sewage had a marked effect in reducing heavy biological growths in the river below the sewage plant and thus saved the city from impending legal action by riparian owners below.[14]

Sludge Conditioning and Chemical Precipitation with Chlorinated Copperas and Ferric Chloride.—Seeking a cheap source of ferric iron salts for conditioning activated sludge in vacuum filtration Mohlman and Palmer at Chicago (1926) found that ferrous sulphate, commonly known as "copperas," after oxidation with liquid chlorine served as a very satisfactory and inexpensive coagulant.[25] Shortly following the Chicago work Fugate and Stanley applied chlorinated copperas experimentally for sludge conditioning which work has resulted in a large scale installation at the Houston, Texas, plant.[26]

Milwaukee, Wisc., was the first (early 1927) to employ chlorinated copperas for dewatering activated sludge on a large scale.[27,28] In this development H. M. Heisig, Chief Chemist, and his staff at the Milwaukee plant, together with D. P. Smith of the Pennsylvania Salt Mfg. Co. are due credit for solving the several difficulties involved in such large scale production of the chlorinated copperas. Ferric chloride seems to be somewhat superior to chlorinated copperas in the Milwaukee plant and will be employed in the future, unless the overall cost of dewatering and drying favors return to chlorinated copperas. Sulphuric acid is at all times employed in the conditioning process in conjunction with the coagulants. Daily tests are conducted in order to secure the most economical combination of acid and ferric salts. At times aluminum salts may be employed also, if the price favors their use. In summer little if any conditioning agent other than the acid is employed. Research at Milwaukee has been productive in materially lowering the cost of sludge dewatering and drying during the

past year. The most recent data available to the author indicates a chemical cost of something under $3.00 for each ton of fertilizer produced.

Houston, Texas, employs chlorinated copperas and Charlotte, N. C., employs ferric chloride. Pasadena, Calif., and Indianapolis, Ind., are experimenting with ferric chloride also.

Chlorinated copperas is prepared at Milwaukee, Houston, and Chicago, by the addition of chlorine gas to a concentrated solution of copperas ($FeSO_4{:}7H_2O$) as described by Mohlman and Palmer.[25] At Elizabeth City, N. C., a dry feeder supplies the desired flow of copperas to produce a solution into which a continuous flow of chlorine water from a Wallace & Tiernan chlorinator is introducted en route to the point of application. The reaction involved is simple and extremely rapid—

$$FeSO_4{:}7H_2O + Cl^0 = Fe^{+++} + SO_4^{--} + Cl^- + 7H_2O$$

In practice one pound of chlorine serves to oxidize the iron in 7.8 to 8.2 pounds of copperas, depending upon the ferrous iron content of the copperas. The use of chlorine in tank car or multiple unit ton container shipments[1] renders the cost of producing chlorinated copperas much more attractive than is the case when chlorine is purchased in 150 pound cylinders.

Ferric chloride is shipped to Milwaukee from Niagara Falls in rubber lined tank cars. The solution contains roughly 50 per cent $FeCl_3$ and is stored at Milwaukee in rubber lined tanks built especially for the purpose. Smaller plants purchase the crystal ferric chloride which is not only more expensive but more difficult to handle. Anhydrous ferric chloride is obtainable and probably has a future in small installations if not at large plants.

As an agent for chemical precipitation "alumino-ferric" compounds have been successfully employed for years in England. In America copperas in combination with lime, or aluminum sulphate in combinations with acid or lime have been favored.

In connection with chemical precipitation of alkaline wastes including laundry waste water ferric chloride or chlorinated copperas in conjunction with acid seems to have considerable merit. Nothing to date has been published concerning this but experimental applications now under way seem very promising. Ferric chloride and chlorinated copperas seem to rank about equal in merit and therefore any preference is governed almost entirely by economic considerations. The major advantage from use of a ferric salt is the lack of necessity for lime application which usually means less sludge to handle subsequently.

We have reports of successful application of ferric chloride in cannery waste precipitation and work is to be undertaken in connection with its application in the treatment of creamery wastes.

Bibliography

[1]Robert T. Baldwin, "The One Ton Liquefied Chlorine Gas Container." Jour. A. W. W. A., Oct., 1927.
[2]W. D. Tiedeman, Engineering News Record, June 9, 1927.
[3]W. J. Scott and C. L. Poole, Eng. News Record, Dec. 29, 1927.
[4]W. S. Mahlie, Public Works, July, 1927.
[5]L. H. Enslow, Water Works, Dec. 1927; The Surveyor, Feb. 1928; American City, May, 1928.
[6]G. H. Hackmaster, Eng. News Record, Dec. 29, 1927.
[8]J. L. Barron and R. E. Lawrence, Univ. of Kansas, Eng. Bul. No. 16, Feb. 1928.
[9]W. J. O'Connell, Proce. N. J. Sewage Works Assoc., 1928.
[10]C. W. Sparmaker and L. Forman, Sewage Works Assoc., 1928.
[11]F. P. Sissons, The Surveyor (London), July 13, 1928; Contract Jour., Oct. 13, 1928.
[12]E. A. Reinke, Sewage Works Journal, Vol. 1 No. 1, 1928.
[13]R. F. Goudey (Sewage Works Journal, Vol. 1 No. 1, Jan. 1929) Calif. Sewage Works Journal, Vol. 1 No. 1, 1928.
[14]F. R. Mieder. Tech. Gemein, Vol. 28, page 183.
[15]Morris Cohn, Eng. News Rec., Aug. 11, 1927.
[16]Gordon Fair and C. M. Carlson, Eng. News Record, Dec. 29, 1927.
[17]Chester Cohen, Eng. News Rec., Apr. 7, 1927.
[18]Chester Cohen, Sewage Works Journal, Vol. 1, No. 1, 1928.
[19]A. C. Harrington and C. E. Whittaker, Eng. News Rec., Aug. 11, 1927.
[20]F. E. Hale, Water Works Eng., Aug. 3, 1927.
[21]R. J. Morton, Thesis, Harvard Engineering School, 1926.
[22]C. D. McGuire, 20th Annual Report Div. Sewage, Columbus, Ohio, 1927.
[23]H. G. Baity and F. M. Bell. Jour. N. Carolina Water & Sewage Assoc. (Vol. 6 No. 1, 1928) and Univ. N. Carolina Eng. Bulletin No. 2.
[24]L. L. Hedgepeth and Wm. C. Olsen. "Chlorinated Copperas—A New Coagulant." Jour. AWWA, Oct. 1928.
[25]F. W. Mohlman and J. R. Palmer. Eng. News Rec., Jan. 26, 1928.
[26]G. L. Fugate and W. S. Stanley. Proc. Tenth Texas Water Works Short School, Jan, 1928; Sewage Works Journal, Vol. 1 No. 1, 1928.
[27]Robert Cramer and J. A. Wilson, Ind. and Eng. Chem., Jan. 1928; Public Works, Jan. 1928.
[28]Robert Cramer. Eng. News. Rec., Nov. 10, 1927.
[29]Y. Henderson and H. W. Haggard, Jour. Ind. and Eng. Chem., June 1922; U. S. Patent 1,410,249.
[30]V. M. Coates. The Paper Mill, Nov. 10, 1928.
[31]L. H. Enslow. The Paper Mill, Dec. 8, 1928 (p. 20).
[32]F. K. Wing and Roger Williams. Eng. News Record, Apr. 18, 1929 (p. 621).
[33]F. W. Mohlman. Proc. 11th Texas Water Works Short School, 1929.
[34]E. A. Reinke. Calif. Sewage Wks. Jour., Vol. 1 No. 1, 1928 (p. 128).

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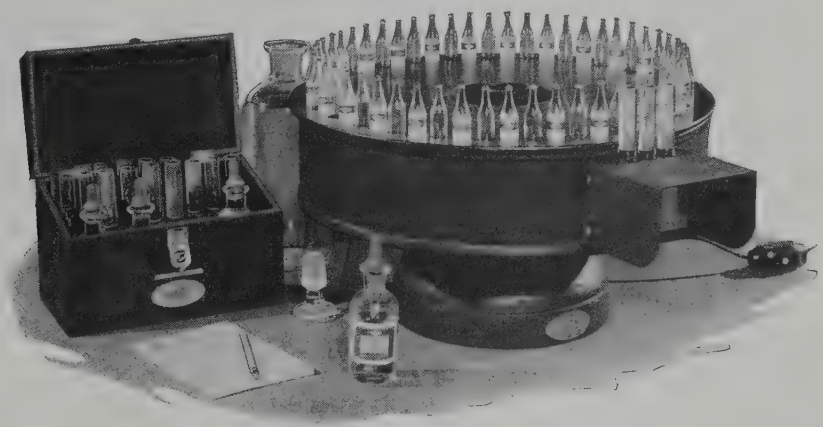

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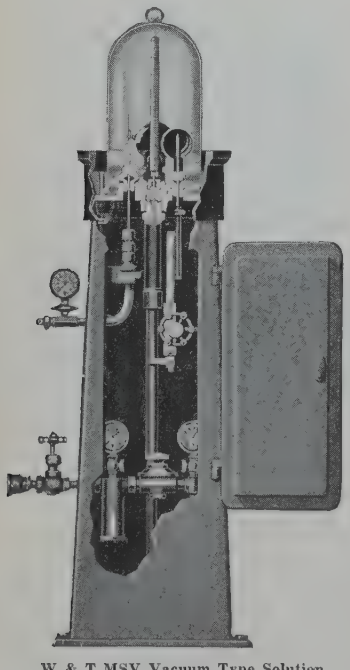
Chlorination: The rapid growth of chlorination practice and the corresponding rapid reduction in typhoid fever death rates parallel so closely that graphs are complete proof of the value of 100% sterilization of water supplies. It can be truly said that every watershed in the country is subject to pollution.—Pollution has spread with the rise of cities and the travel of automobiles. The ground waters are being contaminated in myriad ways,—"*The only safe water is a sterilized water.*"

Liquid chlorine is the cheapest most efficient agent for the sterilization of drinking water, for the disinfection of sewage and for the sanitation of swimming pools. Applied in minute amounts it will destroy any disease organisms of water. Its use will completely prevent the transmission of water borne typhoid fever, dysentery and cholera.

Chlorination sterilizes 100,000 gallons of water for an average of three cents. Liquid chlorine is safeguarding the water supplies of over 5,000 municipalities using a total of six billion gallons of water each day. No flight of the imagination can suggest a more valuable work than the campaign of sanitarians and public health engineers "To Guard the Public Health" by demands for careful sterilization of all public water supplies.

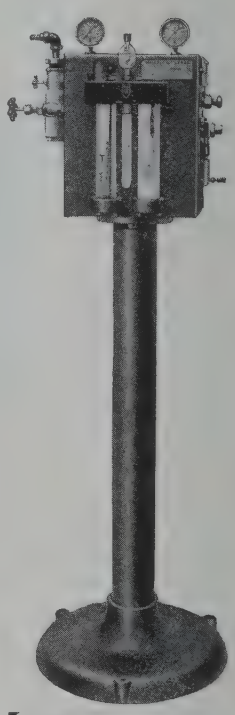
Ordinary standards of sanitation—the sense of civic responsibility and the staggering cost of an epidemic—are there any better reasons to urge every community to enforce such simple protection? The chlorinator is final protection. The chlorinator works when all other treatment fails.



W & T MSV Vacuum Type Solution Feed Chlorinator
"The Peer of All Chlorinators"

Vacuum Type Chlorinator: Simplicity of operation is the outstanding advantage of the W. & T Vacuum Type Solution Feed Chlorinator. Small fragile parts are eliminated. The apparatus, is designed so that no moving parts can be out of adjustment. The entire apparatus is hydraulic in principle and no parts are moving when the chlorinator is in operation. The fundamental advantages of all W & T Chlorinators are retained with the same high percentage accuracy of chlorine flow.

The MSP Type Chlorinator is designed to meet the varied requirements of the average small water works. The operation of the equipment is evident in the detail drawing. The solution feed assures better diffusion of the sterilizing solution than the direct feed. Either pressure application or gravity feed of the chlorine solution is possible it being only necessary that a water supply under sufficient pressure be available for operation.



Duplicate MSP Chlorinators are Safeguarding the Water Supply of Hundreds of Small Cities Throughout the World.

The primary aim has been to produce a machine which will not only accurately control the necessarily small amount of chlorine but will also be of such simple construction as to be readily understood by the practical water works man. The progress of chlorination is the history of Wallace and Tiernan. For, the prerequisite of successful chlorination is a sturdy, dependable, accurate chlorinator.

Sterlization is accomplished not with tons of chlorine for every every million gallons but it is the work 0.3 to 1.2 parts per million. The accuracy of treatment is comparable to the most exact chemical analyses. One part per million is equivalent to eight and three tenths pounds of chlorine in one million gallons of water.—Chlorination is a real problem of accuracy.—But dependability is even more important than accuracy. Chlorination means correct, reliable operation every minute of every day. The Wallace & Tiernan Vacuum or Pedestal Type Chlorinator bears little resemblance to the pioneer of 10 years ago. The radical changes were not for accuracy but solely to perfect equipment independent of mechanical vital moving parts. The production of hydraulically operated apparatus gained the complete confidence of the engineering and water works profession—a confidence so firm that chlorination and sterilization are synonymous.

Briefly, a Wallace & Tiernan chlorinator is the product of constant effort—ingenious design and practical experiment, so, it is the scientific apparatus, complete in every detail, the standard of perfection—exact, yet simple to operate.

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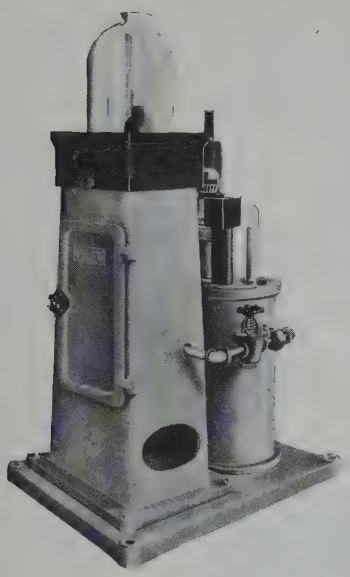


W & T ASV Vacuum Type Automatic Solution Feed Chlorinator

Were the field of usefulness of chlorine limited to sterilization it would be "good work well done." But the practical research of investigators during the last few years has extended the use to include algae control—taste control—improved coagulation (with chlorinated copperas and prechlorination) and to use in sewage treatment for odor control and reduction of the biochemical oxygen demand.

Chlorination for Algae Control: L. B. Mangun, superintendent of the Kansas City Filtration Plant, has had marked success controlling algae in the distribution reservoirs with chlorination. Chlorine is preferable to copper sulfate since the dosage can be accurately controlled and there is no fear of controversy in case some of the chlorine remains in the treated water. Algae control is successful in such scattered localities as New York and Texas, Virginia and New Jersey.

Chlorination of raw water at filter plants further than increasing bacterial safety and destroying algae permits longer filter runs and is reported to allow a reduction in dosage of coagulant—while, the consequent prevention of "slime" on the sand grains means less trouble from "cracking" and mud balls,—Mention of coagulants should include chlorinated copperas (ferrous sulfate) with its wide coagulating pH range and particular advantages for color removal.

Superchlorination and dechorination, first practiced on a large scale at Toronto, promise solution of many water tastes problems. An excess dosage of chlorine will destroy organic tastes and the residual chlorine is neutralized by correct dosage of sulfur dioxide. (Sulfur dioxide is measured and fed with W & T equipment.)

Chlorination of Sewage and Wastes: As to sewage—its odors are principally hydrogen sulfide—chlorination will not only destroy H_2S but will retard the bacterial action producing it. Sewage treatment is not a process of sterilization unless chlorination is a part, but chlorination is not only sterilization it is definitely a treatment process which reduces the biochemical oxygen demand by 25-30%.

The industrial uses of chlorine requires careful control. Chlorine solutions of accurate concentration are invaluable in laundries. The utensils of dairies, canneries and bottling works are most easily and perfectly sterilized, with carefully made chlorine solutions. Even oysters are chlorinated as an additional precaution to protect the consuming public. "Slime" in paper mill vats—the cause of weakness and flaws in stock—is destroyed by correct chlorination. The "slime" growths in steam condensers are prevented by chlorination—the control of slime means a saving in steam and a saving of cleaning labor. The textile mills bleach with chlorine. Highly colored dye wastes may be decolorized by chlorination.

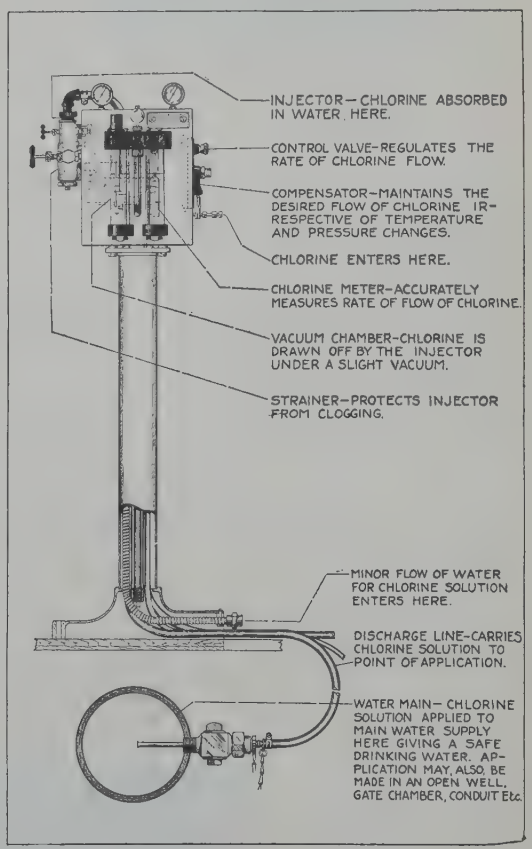
At best the major uses have only been mentioned but progress, improvement and new ideas indicate increasing possibilities of unrecognized value.

Automatic Chlorination: The automatic application of liquid chlorine for water sterilization and sewage disinfection is highly important wherever there are rapid changes in the rates of flow or under variations between maximum and minimum flows.

Automatic chlorination is not news, but the new success of the W & T Automatic Chlorination is news. The first ASV chlorinator was installed in 1927. Today Seattle, Los Angeles, Chicago, New Haven, Portland, Maine, Birmingham, Bridgeport, Baltimore, Rotterdam, Holland, depend upon the automatic chlorinator for "safe water." The equipment is a development of the W & T Vacuum type chlorinator. It has the same accuracy and the same hydraulically operated chlorine control, but, in addition, the automatic control of dosage is entirely hydraulic. In fact, there is even less lag in the change of dosage of chlorine than in a Venturi recorder.

The differential head obtained by the flow of water through a venturi tube, orifice plate, pilot rod or over a weir, is transmitted to a differential reducing device which varies the vacuum head on the chlorine meter in the vacuum chamber of the chlorinator precisely in proportion to the flow of water to which the chlorine is being applied. An accuracy test of one of these units after several weeks operation indicated that the average variation of chlorine flow from the theoretically correct chlorine flow was only 0.38 of 1% the maximum error being 3% and the minimum error zero.

The Automatic Vacuum Chlorinator is the solution of sterilization problems where there are rapid changes in the rates of flow or where there are wide variations between maximum and minimum flows.


INJECTOR—CHLORINE ABSORBED IN WATER HERE.
CONTROL VALVE-REGULATES THE RATE OF CHLORINE FLOW.
COMPENSATOR—MAINTAINS THE DESIRED FLOW OF CHLORINE IRRESPECTIVE OF TEMPERATURE AND PRESSURE CHANGES.
CHLORINE ENTERS HERE.
CHLORINE METER—ACCURATELY MEASURES RATE OF FLOW OF CHLORINE.
VACUUM CHAMBER—CHLORINE IS DRAWN OFF BY THE INJECTOR UNDER A SLIGHT VACUUM.
STRAINER—PROTECTS INJECTOR FROM CLOGGING.
MINOR FLOW OF WATER FOR CHLORINE SOLUTION ENTERS HERE.
DISCHARGE LINE—CARRIES CHLORINE SOLUTION TO POINT OF APPLICATION.
WATER MAIN—CHLORINE SOLUTION APPLIED TO MAIN WATER SUPPLY HERE GIVING A SAFE DRINKING WATER. APPLICATION MAY, ALSO, BE MADE IN AN OPEN WELL, GATE CHAMBER, CONDUIT Etc.

Manual Control Chlorinator Solution Feed Type MSP and MSPM.

The installation of W & T chlorine control apparatus only requires minor construction and piping easily arranged by the water department mechanic.

It is advisable to house the chlorinator where the room temperature is evenly maintained above 50° F. The installation of W & T equipment is supervised by W & T engineers.

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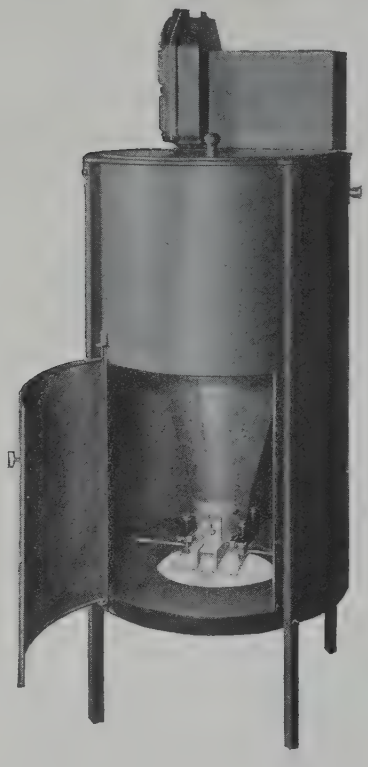
W & T Dry Chemical Feeders



W & T Dry Chemical Feeder Type "O" Rugged—Compact—Reliable.

Type "O" Feeder: This new dry chemical feeder is essentially a low capacity feeder, having a feed range from 1/10 pound to 80 pounds per hour, depending on the chemical fed. It may be used with either course granular crystalline chemicals such as alum or with the finer powdered chemicals as lime.

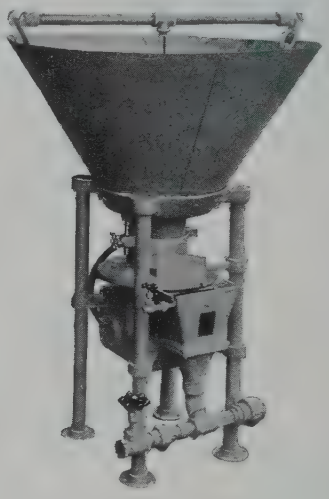
The entire machine with the exception of motor and gear case which are separately encased, is enclosed by a sheet metal housing with tight fitting doors. A cover is provided for the hopper.

The steep sloping hopper is agitated by an unique system of levers which flex so as to keep every particle of chemical moving at all times. This gives the chemical an even consistency and a uniform rate of feed into the throat. Thus arching and its troublesome operating difficulties are eliminated.

The 1/6 H. P. constant speed motor is directly connected. There are no pulleys or belts to worry about. It may be operated from an ordinary light socket. Power consumption is remarkably low. It takes less that 5 k. w. per day

The adjustment by a conveniently located hand wheel geared to a scale lever is an outstanding feature of the feeder. A 200 division scale permits great ease and accuracy of adjustment. The feeder is adaptable for overhead feed if desired. Feed to the point of application may be direct through a 12" sheet metal pipe or as a solution using a special W & T Solution pot. The finish is neat and durable. All exposed parts are either painted with W & T Gray Duco finish or are cadmium plated.

W & T Type B Chemical Feeder is manufactured in two capacities. One is known as the low speed feeder and the other as the high speed feeder. Depending on the pulley size and the chemical used the low speed feeder has a minimum rate of feed of 0.5 pound per hour and a maximum of 150 pounds per hour. The high speed feeder has a similar range of 7.5 minimum and 1,080 maximum, in pounds per hour.

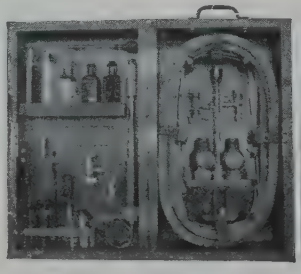


W & T Type B Dry Chemical Feeder.

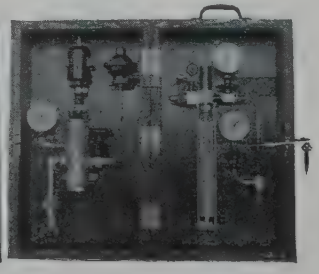
In the W & T Type B Dry Feeder the pulverized or granular chemical is placed in the hopper. The chemical flows on to a revolving feed table through the feed spout. This table together with suitable agitator mechanism is belt driven from an electric motor, water motor or line shaft. A stationary scraper removes the chemical from the revolving feed table diverting it to the receiving hopper from which it may be conducted by gravity to the point of application as a dry chemical. If desired the chemical may be mixed with water in the receiving hopper and the solution fed through a water operated injector to the point of application.

Chlorinator for Sterilization Water Mains

Every new or repaired water main should be sterilized before being put into service. Chlorine is the most efficient and economical chemical to use. Periodic chlorination of water mains will positively prevent objectionable after-growths in the distribution system.



Cabinet with Accessories and Residual Chlorine Testing Equipment

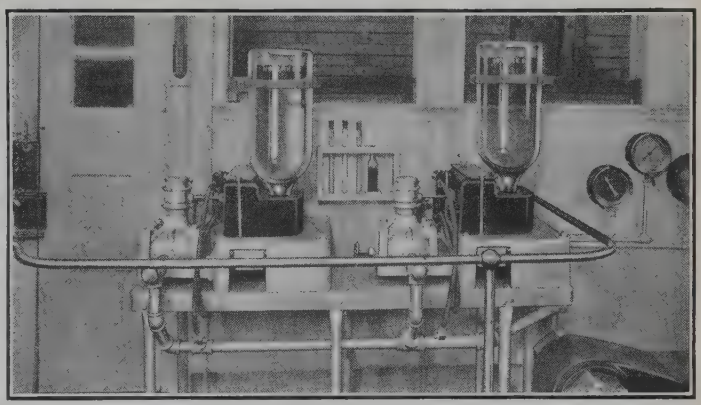


Cabinet with Chlorinators for Direct or Solution Feed.

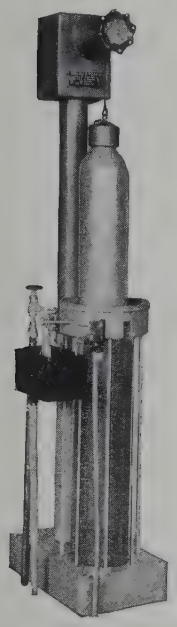
The new W & T Main Sterilizer provides for either direct or solution feed chlorination to the main. The apparatus is supplied with complete equipment for field chlorination and for making the necessary Ortho Tolidin test for residual chlorine. Every water works should own one of these sterilizers.

Continued on Next Page

The W & T Chlorometer is designed for sterilization of small water supplies. It is particularly adapted to the sterilization of supplies operated by automatic pumping systems. Hotels, private estates, country homes and boats on the Great Lakes use the W & T Chlorometer to insure the absolute safety of their domestic water supplies. Sterilizing solution will be introduced only when water is passing through the meter and at a rate proportional to the flow. While intended for small water supplies the Chlorometer has a wide range of usefulness for the proportional feed of many chemical solutions. Accurate, rugged, simple, fool-proof, it can be made absolutely automatic in operation, requiring no attention other than replenishing the three gallon bottle of sterilizing solution.



"Two W & T Chloro-Meters Installed to Sterilize the Drinking Water Supplied to the Steamship 'Western States,' Detroit and Cleveland Navigation Company."



"The W & T Chloro-Clock."

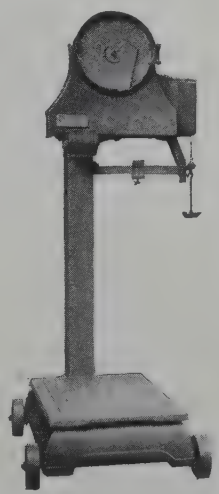
The W & T Chloro-Clock is the simplest accurate control device used in water sterilization. It is the ideal apparatus for chlorination of small swimming pools and constant flow water supplies. The control of treatment is obtained from a clock-work mechanism which regulates the rate of travel of a displacement cylinder. Adjustments in the rate of displacement and feed of sterilizing solutions are made by a pendulum control lever.

As with the Chlorometer, the Chloro-Clock may be fitted to regulate dosages of any chemical solution either required by industrial processes or as used in water works treatment. The Chloro-Clock is particularly recommended where the use of liquid chlorine is considered inadvisable as it is reliable, safe equipment requiring a minimum of attention.

The W & T Chloroscale gives a chart of the total amount of chlorine fed during a given period of time and a graph of the rate of chlorine flow from the cylinders.

A special clock mechanism revolves the chart while an accurately adjusted escapement mechanism automatically balances the scale beam, moving the pen across the face of the chart at a rate proportional to the rate of chlorine flow.

The W & T Chloroscale is furnished in response to a demand from water works superintendents and public health engineers for an automatic record of chlorinator operation.



"The W & T Chloro-Scale."

Wallace & Tiernan is an organization of highly trained technical men familiar with the fields of sanitation, bacteriology, chemistry and engineering, and is a staff of experts in the specialty of chlorination. The community worried with sanitary problems profits by advice of a Wallace & Tiernan representative,—he is a consultant on the applications of chlorine.

Who are Wallace & Tiernan? Wallace & Tiernan is an organization of highly trained technical men familiar with the fields of sanitation, bacteriology, chemistry and engineering, and is a staff of experts in the specialty of chlorination. The community worried with sanitary problems profits by advice of a Wallace & Tiernan representative,—he is a consultant on the applications of chlorine.

Every proposal is considered as an individual engineering problem and every installation is recognized as a responsibility for human life. The selection of correct types of equipment with proper capacities depends on detail differences in water systems and the variable character of waters. The selection can only be based on technical knowledge and on judgment of experience.

There are more than 10,000 installations of W & T equipment throughout the world for the sterilization of water, for the disinfection of sewage, for swimming pool sanitation, for deodorization and for the many purposes in industry or sanitation. The services of our Engineering and Research Departments are available for the solution of new problems.

Service is the business of Wallace & Tiernan so feel free to call for information on chlorination, sanitation, water works, or industrial operations. When a W & T Chlorinator is ordered you purchase continued cooperation and service from a nationwide field staff. The installation of the chlorinator is only the start of W & T's work.—From then on you will appreciate the motto "SERVICE."

Terms Used in Sewerage and Sewage Disposal Practice

The following was taken from *Municipal News and Water Works:*

The formulation of definitions of terms used in sewerage work was initiated in 1915 by the American Public Health Association. The work was continued by the committees of the Association until 1924. In May of that year the Sanitary Engineering Division of the American Society of Civil Engineers appointed a committee on definitions. Joint action between the two societies followed and an Oct. 22, 1924, at a joint meeting of the Sanitary Engineering Division of the American Society of Civil Engineers and the Sanitary Engineering Section of the American Public Health Association, a tentative report based on the work of the two committees was presented. The work was then continued and on Oct. 13, 1927, the joint report of the two committees was adopted by the Sanitary Engineering Division of American Society of Civil Engineers. The American Public Health Association adopted this report on Oct. 20, 1927, and on July 16, 1928, the report was also adopted by the Board of Directors of the American Society of Civil Engineers. The latter society has published recently the list of definitions as one of its manuals of engineering practice.

Definitions of Terms Used in Sewerage and Sewage Disposal Practice

A. B. C. Process (Alum, Blood, Clay).—A method of deodorizing and precipitating sludge by the addition of alum, charcoal, or some other material and clay, to the raw sewage. One of the earliest satisfactory methods of clarification by chemical precipitation.

Activated Sludge.—Sludge settled out of sewage previously agitated in the presence of abundant atmospheric oxygen.

Activated Sludge Method.—See **Activated Sludge Process.**

Activated Sludge Process.—Sewage treatment in which sewage in or flowing through a tank is brought into intimate contact with air and with biologically active sludge, previously produced by the same process. The effluent is subsequently clarified by sedimentation.

Aeration.—The process or method of bringing about intimate contact between air and a liquid by allowing finely divided air to pass through the liquid or the finely divided liquid to pass through air.

Air-Lift.—A device for raising sewage or other liquid by injecting air in and near the bottom of an open discharge pipe submerged in a well of the liquid to be raised.

Alignment.—The direction of the axis of a sewer in plan.

Alternating Device.—A device whereby sewage may be automatically delivered into different parallel treatment units in a cycle following a predetermined sequence.

Appurtenances.—See **Sewer Appurtenances.**

Back-Water Gate.—A device for preventing the back flow of sewage or water.

Baffles.—Deflectors of wood, metal, or masonry placed in flowing liquid to divert, guide, or agitate the flow of such liquid.

Band Screen.—An endless band or belt of wire mesh, bars, plates, or other screening medium, which passes around upper and lower rollers or guides.

Bar Screen.—A screen composed of parallel bars or rods. See, also, **Rack.**

Barn Sewage.—Wash water from stables, considerable quantities of animal wastes.

Basin.—A shallow tank or natural or artificial depression through which liquids pass or in which they are detained for treatment.

Bio-Aeration.—A modification of the activated sludge process in which the sewage and sludge are agitated and aerated by mechanical means, such as paddle-wheels or turbines.

Bio-Chemical Action.—Chemical action resulting from the growth or metabolism of living organisms.

Bio-Chemical Oxygen Demand.—The quantity of oxygen required for biochemical oxidation in a given time at a given temperature, the determinations usually be for 5 days at 20° cent.

Biolytic Tank.—A continuous flow tank with hopper bottom, with inlet arranged so as to agitate the sludge by the entry of sewage at the apex of the hopper-shaped bottom. This agitation tank is sometimes followed by a settling tank in which the sludge is detained until removed.

Bleach.—Calcium hypochlorite. (Bleaching Powder.)

Blow-Off.—A waste-gate or device for discharging accumulated solids or for emptying a depressed sewer.

Branch Sewer.—An arbitrary term for a sewer which receives sewage from a relatively small area.

Branches.—Special forms of vitrified tile and cast iron pipe for making connections to a sewer. They are called Tee-Y, Double-Y, and V, from the shapes. (Synonym, Junction Pieces.)

Broad Irrigation.—The disposal of sewage by application to farm land involving the incidental benefit to crops growing out of the irrigation and fertilization resulting from the application of the sewage. (Differs from sewage farming in that the primary purpose is the disposal of sewage, while the raising of crops is incidental only.) See, also, **Sewage Farming.**

Cage-Screen.—A screen consisting of a cage, with sides of bars, rods, or mesh, so arranged that it may be lowered into the sewage and raised therefrom for cleaning.

Capillary Water.—Water in the interstices of the soil or of a sand filter, which is not lost by draining.

Catch-Basin.—A chamber or well, designed to prevent the admission of grit and detritus into a sewer.

Catch Pit.—See **Grit Catcher.**

Catchment Area.—The area of a water-shed tributary to a lake, stream, or sewer.

Centrifuge.—A device in which sludge is dewatered by rapid rotation and automatically discharged.

Cesspool.—A pit into which household sewage or other liquid waste is discharged and from which the liquid leaches into the surrounding soil, or is otherwise removed.

Chamber.—A general term for a space enclosed by walls or a compartment, often prefixed by a descriptive word as "grit chamber" or "screen chamber" indicating its contents, or "discharge chamber" or "flushing chamber" indicating its office.

Chemical Precipitation.—Sedimentation accelerated by the coagulation of suspended or colloidal matter through the addition of chemicals.

Chlorination.—Treatment with chlorine or bleaching powder for the purpose of disinfection, the retardation of decomposition, or the oxidation of organic matter.

Circumferential Flow.—Flow parallel to the periphery of a circular tank.

Clarification.—The process of removing suspended and colloidal matter from a turbid liquid.

Clarified Sewage.—Loosely used for sewage from which suspended matter has been partly or completely removed.

Coagulation.—The flocculation of colloidal or suspended matter brought about by the addition of some chemical to the liquid, by contact, or by other means.

Coarse-Grained Filter.—General term for contact bed or trickling filter.

Coarse Rack.—A relative term, but generally used when the clear space between bars is 2 in. or more.

Coarse Screen.—A relative term, but generally used when openings are greater than 1 in. in least dimension, except in the case of racks. See, also, **Coarse Rack.**

Coefficient of Imperviousness.—The ratio, expressed decimally, of effectively impervious surface to the total catchment area.

Collecting System.—All sewers from the house to the outfall. See, also, **Sewerage System.**

Colloidal Matter.—Colloids or matter colloidal in character and action.

Colloids.—(1) The finely divided suspended matter which will not settle and the apparently dissolved matter which may be transformed into suspended matter by contact with solid surfaces or preciptated by chemical treatment. (2) Substances which are soluble as judged by ordinary physical tests, but will not pass through a parchment membrane.

Combined Sewer.—A sewer designed to receive both storm and sewage.

Combined System.—A system of sewers, in which sewage and storm water are carried in the same conduits.

Commercially Dry Sludge.—Sludge containing not more than 10 per cent of moisture by weight.

Common Sewer.—A sewer in which all abutters have equal rights.

Compartment.—A chamber in, or a division of, a structure for sewage treatment.

Concentrated Sewage.—A relative term. Sewage containing a relatively large quantity of organic matter.

Conditioning.—See **Sludge Conditioning.**

Contact Aerator.—A device consisting of a crate holding broken stone, coke, brushwood, or other media, which is placed in a single, or two-story sedimentation tank and through which the sewage is made to flow upward and return on the outside and become activated by the admission of compressed air below.

Contact Bed.—An artificial bed of coarse material, such as broken stone or clinkers, in a water-tight basin provided with controlled inlet and outlet. It is operated in cycles of filling with sewage, standing full in contact, emptying, and resting empty, in order to remove some of the suspended matter and oxidize organic matter by bio-chemical agencies.

Contaminated Water.—Water unfit for any given use because of contact with or the presence of injurious substances.

Contamination.—The introduction into water, otherwise satisfactory, of bacteria, sewage, or other substance, which makes it unfit for any given use.

Cover.—See **Manhole Head.**

Crown.—The inside top of a sewer.

Crude Sewage.—Sewage which has received no treatment.

Datum.—Plane of reference for elevations.

Degreasing.—The process of removing fats and greases from sewage, waste, or sludge.

Degree of Purification.—A measure of the removal and oxidation of the objectionable or putrescible contents of sewage.

Depressed Sewer.—A sewer, often crossing beneath a valley or a water course, which runs full or under greater than atmospheric pressure becaues its profile is depressed below the hydraulic grade line.

Detritus Tank or Chamber.—A detention chamber larger than a grit chamber, usually with provision for removing the sediment without interrupting the flow of sewage. A settling tank of short detention period designed, primarily, to remove heavy settleable solids.

Diffuser.—A porous plate or other device through which air is forced and enters the sewage in the form of minute bubbles.

Digestion.—The bio-chemical decomposition of organic matter resulting in the formation of mineral and simpler organic compounds.

Dilute Sewage.—A relative term. Sewage containing a relatively small quantity of organic matter.

Dilution.—(1) A method of disposing of sewage or effluent by discharging into a stream or other body of water. (2) The ratio of the volume of flow of a stream to the volume of sewage or effluent discharged into it.

Direct Oxidation Process.—(So-called.) A proprietary method of treatment in which sewage previously dosed with lime is passed through closed tanks between plate electrodes across which electric current is passing while the liquid is agitated by rotating paddles.

Disc Screen.—A screen in the form of a circular disc rotating about an axis perpendicular to its center.

Discharge Sewer.—See **Outlet Pipe.**

Disinfected Sewage.—Crude sewage, or a sewage plant effluent which has been treated with a disinfecting agent, commonly chlorine or "bleach," resulting in the destruction of bacteria sufficiently to reduce materially the danger of infection.

Disinfection.—The partial destruction, ordinarily by the use of some chemical, or the micro-organisms likely to cause infection and disease.

Dispersion.—A method of disposal of the suspended solids in sewage or effluent by scattering them widely in a stream or other body of water.

Distributor.—A device used to apply sewage to the surface of a filter. There are two general types, fixed and movable. The fixed type may consist of perforated pipe or notched troughs, sloping boards, or sprinkler nozzles. The movable type may consist of rotating or reciprocating perforated pipes or troughs applying spray or a thin sheet of sewage.

Diversion Chamber.—A chamber which contains a device for diverting all or a part of the flow.

Diversion Manhole.—See **Diversion Chamber.**

Domestic Sewage.—Sewage derived principally from dwellings, business buildings, institutions, and the like. (It may or may not contain ground-water, surface water, or storm water. It may also contain a small proportion of industrial waste liquid.)

Dorr Thickener.—(Clarifier.) A proprietary device placed in a tank by which a system of scrapers, driven by a central shaft, revolves slowly, pushing the deposited sludge to a central outlet, from which it is removed by gravity or pumping.

Dortmund Tank.—A vertical-flow sedimentation tank with hopper bottom. The sewage, introduced near the bottom, rises and overflows at the surface, and the sludge may be removed from the bottom before it becomes septic.

Dosing Chamber.—See **Dosing Tank.**

Dosing Siphon.—An automatic siphon for discharging the contents of a dosing tank.

Dosing Tank.—A tank into which raw or partly treated sewage is introduced and held until the desired quantity has been accumulated, after which it is discharged at such a rate as may be necessary for distribution essential to the subsequent treatment.

Drain.—Conduit or pipe, usually underground, for carrying off, by gravity, liquids or other than sewage and industrial wastes, and including ground or subsoil water, surface water, and storm water.

Drainage.—A general term for gavity flow of liquids in conduits. Commonly applied to surface and ground-water.

Drainage System.—A system of drains.

Drainage Water.—Water flowing in a drain derived from ground, surface or storm water.

Drop Manhole.—A shaft in which sewage falls from a sewer to a lower level.

Drum Screen.—A screen in the form of a cylinder or truncated cone rotating on its axis.

Dry-Weather Flow.—Flow of sewage in a sewer during dry weather.

Effluent.—Sewage, partly or completely treated, flowing out of any sewage treatment device.

Effluent Discharge Conduit.—See **Outlet Pipe.**

Ejector.—See **Pneumatic Ejector.**

Emscher Filter.—See **Contact Aerator.**

End Manhole.—One at the up-stream end of a sewer.

Entrance Well.—See **Inlet Well.**

Evaporation.—Vaporization of moisture from a wet surface.

Filtered Sewage.—The effluent of a sewage filter.

Filtering Medium.—The material through which sewage applied to a filter must pass.

Filtration.—(1) The process of removing suspended and colloidal matter from a liquid and the oxidation of its dissolved organic matter, by causing it to flow through a relatively fine porous medium. (2) Sometimes loosely applied to the removal of solids and liquid organic matter in treatment beds.

Filtros.—The trade name applied to an artificial porous stone made of carefully graded silicious sand by moulding, pressing, firing, annealing, and grinding. It is used as a filtering medium and for diffusing air in the activated sludge process.

Final Settling Basin.—A tank through which the effluent of a trickling filter, or other oxidizing device, passes for the purpose of removing the settleable solids before its discharge.

Final Settling Tank.—Same as final settling basin, but deeper and of less area.

Fine Rack.—A relative term, but generally used when the clear space between the bars is 1 in. or less.

Fine Screen.—A relative term, but generally used for a screen with openings ¼ in., or less, in least dimension.

Flaring Inlet.—A funnel-shaped entrance to facilitate flow into a pipe or conduit.

Flotation.—A method of collecting suspended matter in a tank as a scum at the surface by the evolution of gas by chemicals, electrolysis, heat, or bacterial decomposition.

Flowing-Through Chamber.—The upper compartment of a 2-story sedimentation tank.

Flush Tank.—A chamber in which water or sewage is accumulated and discharged at intervals for flushing a sewer.

Flushing Chamber.—See **Flush Tank; Flushing Manhole.**

Flushing Manhole.—A manhole provided with a gate so that sewage or water may be accumulated and then discharged rapidly for flushing a sewer.

Frame.—See **Manhole Head.**

Fresh Sewage.—Sewage of recent origin still containing free disssolved oxygen.

Gas Slot.—See **Gas Vent.**

Gas Vent.—(1) A passage to permit the escape of gases of decomposition. (2) An opening which allows gas, liberated in an Imhoff tank sludge digestion chamber, to reach the atmosphere without passing up through the sewage in the settling chamber.

Grade.—Elevation of invert.

Gradient.—See **Slope.**

Grating.—A screen consisting of parallel bars, two sets being transverse to each other in the same plane.

Gravity System.—A system in which all sewage runs on descending gradients from source to outlet, or where no pumping is required.

Grease Trap.—A device by means of which the grease content of sewage is cooled and congealed so that it may be skimmed from the surface.

Grit.—The heavy mineral matter contained in sewage, such as sand, gravel, cinders, etc.

Grit Catcher.—A chamber usually placed at the upper end of a depressed sewer, or at other points of protection on combined or storm-water sewers, of such shape and dimensions as to reduce the velocity of flow and thus permit the settling out of grit.

Grit-Chamber.—A small detention chamber or an enlargement of a sewer designed to check the velocity of the sewage enough to permit the heaviest solid matter, such as grit, to be deposited with a view to its frequent and easy removal. (Grit Compartment.)

Ground-Water.—Water derived from beneath the surface of the ground.

Ground-Water Drain.—A drain which carries away ground-water.

Horizontal Flow Tank.—A tank or basin, with or without baffles, in which the direction of flow is generally horizontal.

House Connection.—See **House Sewer.**

House Sewage.—(1) Sewage from dwellings. (2) Loosely used for domestic sewage.

House Sewer.—A pipe conveying the sewage from a single building to a common sewer or point of immediate disposal.

Humus Sludge.—(1) Digested sludge deposited in final or secondary settling tanks, following trickling filters or other oxidizing device. (2) Sludge resembling humus in appearance.

Humus Tank.—A tank for collecting humus sludge. See, also, **Final Settling Tank; Final Settling Basin.**

Hydraulic Grade.—The elevation of the surface of the liquid in a sewer above an assumed datum.

Hydraulic Gradient.—The surface slope of the liquid in a sewer. Generally taken parallel to the invert.

Hydraulic Inclination.—See **Hydraulic Gradient.**

Hydraulic Slope.—See **Hydraulic Gradient.**

Hydrolysis.—A change in the molecular composition of matter produced by the addition of water.

Hydrolytic Tank.—In general, any sewage tank in which hydrolysis occurs, specifically applied to a special form of vertical flow tank. General term for any sedimentation tank in which, by bio-chemical processes, a part of the suspended organic matter is liquefied and gasified.

Imhoff Tank.—A deep two-storied tank invented by Karl Imhoff, M. Am. Soc. C. E., consisting of an upper or continuous sedimentation chamber and a lower or sludge digestion chamber. The floor of the upper chamber slopes steeply to trapped slots, through which solids may settle into the lower chamber. The lower chamber receives no fresh sewage directly, but is provided with gas vents and with means of drawing digested sludge from near the bottom.

Industrial Sewage.—Sewage in which industrial wastes predominate. See, also, **Domestic Sewage; Industrial Wastes.**

Industrial Wastes.—Liquid wastes from industrial processes.

Infected Water.—Water which contains pathogenic bacteria.

Infection of Water.—The introduction of pathogenic bacteria into water in sufficient quantities to produce disease.

Infiltration.—The leaching of water from the ground into a sewer.

Influent.—Sewage, raw or partly treated, flowing into any sewage treatment device.

Inlet.—A connection between the surface of the ground and a sewer for the admission of surface or storm water.

Inlet Well.—A well or opening at the surface of the ground to receive surface water which is thence conducted to a sewer.

Institutional Sewage.—Domestic sewage from institutions, such as hospitals, sanitariums, or penal and charitable establishments.

Intercepting Sewer.—A sewer which receives the dry-weather flow from a number of transverse sewers or outlets, with or without a determined quantity or storm water if from a combined system.

Intermittent Filter.—A natural or artificial bed of sand or other fine-grained material to which sewage is intermittently applied in doses and through which it flows, opportunity being given for filtration and also oxidation of the organic matter by bio-chemical agencies.

Invert.—Originally, the inverted arch of a masonry-lined sewer. By derivation, the floor, bottom, or lowest point in the internal cross-section of a sewer.

Invert Block.—A voussoir shaped hollow tile built into the invert of a masonry sewer.

Inverted Siphon Sewer.—See **Depressed Sewer.**

Irrigation.—See, **Sub-Surface Irrigation; Surface Irrigation; Broad Irrigation; Sewage Farming.**

Junction Chamber.—A converging section of a sewer used to facilitate the flow from one or more sewers into a main sewer.

Junction Manhole.—A manhole at the junction of two or more sewers.

Kitchen Waste.—Liquid culinary wastes.

Lamp-Hole.—A small vertical pipe or shaft leading from the surface of the ground to a sewer, for admitting a light for purposes of inspection.

Land Drain.—A drain for drawing off water from land. See, also, **Ground-Water Drain.**

Lateral Sewer.—A sewer which discharges into a branch or other sewer and has no other common sewer tributary to it.

Leaching Cesspool.—A cesspool out of which the liquid leaches into the surrounding soil.

Line Manhole.—A manhole in the line of a sewer at a point where no other sewers connect. It may be at a point where the sewer changes direction, either in line, slope, or grade.

Liquid Sludge.—Sludge containing sufficient water to permit it to flow by gravity (ordinarily above 80 per cent).

MacLachlan Process.—(A Proprietary Process.) A method of conditioning sludge preparatory to dewatering by the application of sulfur dioxide gas.

Main Sewer.—A sewer which receives one or more branch sewers as tributaries.

Manhole.—A shaft, or chamber, from the surface of the ground to a sewer, large enough to enable a man to have access for the purpose of inspection and cleaning.

Manhole Head.—The cast-iron fixture surmounting a manhole. It is made up of two parts: A "Frame" which rests on the masonry of the shaft, and a removable "Cover." Frames are either "Fixed" or "Adjustable" in height. Covers are "Tight," "Ventilated," or "Anti-Rattling."

Medium Screen.—A screen having openings intermediate between those of a coarse and a fine screen.

Mesh Screen.—A screen composed of woven fabric, usually of wire.

Miles Acid Process.—A proprietary method of treatment invented by George W. Miles, in which sewage is acidified by sulfurous acid fumes. The fumes are absorbed by a part of the sewage. This part is then mixed with the remainder of the sewage. Subsequent precipitation of solids results in clarification and a measure of disinfection.

Outfall Sewer.—A sewer which receives the sewage from the collecting system and conducts it to a point of final discharge or to a disposal plant.

Outlet Pipe.—A pipe which conveys the effluent from a treatment plant to its final point of disposal.

Oxidation.—See **Sewage Oxidation.**

Oxidized Sewage.—Sewage in which the organic matter has been combined with oxygen and has become stable.

Percolating Filter.—See **Trickling Filter.**

Percolation.—The flow or trickling of a liquid downward through a relatively coarse filtering medium. The liquid usually does not fill the pores of the medium.

Plate Screen.—A screen composed of one or more perforated plates.

Pneumatic Ejector.—A means of raising sewage, other liquid, by alternately admitting it through a check-valve into the bottom of a pot and then ejecting it through another check-valve into the discharge pipe, by admitting compressed air to the pot above the liquid.

Polarite.—Magnetic spongy carbon, formerly used as a filter medium after sedimentation.

Polluted Water.—Water made unclean or injured by sewage, industrial waste, or other substance.

Pollution.—The act of making unclean or impure or the state of being unclean or impure as a result of admixtures of sewage, industrial wastes, or other substance.

Precipitation.—Rain and snowfall. See, also, **Chemical Precipitation.**

Private Sewer.—One privately owned and used by one or more properties.

Public Sewer.—A common sewer controlled by public authority.

Putrefaction.—Biological decomposition of organic matter with the production of ill-smelling products. It occurs under conditions of oxygen deficiency.

Putrescibility.—(1) The susceptibility of waste waters, sewage, effluent, or sludge to putrefaction. (2) The relative tendency of organic matter to undergo decomposition in the absence of oxygen.

Rack.—A screen composed of parallel bars, either vertical or inclined, from which the screenings may be raked.

Radial Flow.—Direction of flow across a circular tank, from center to periphery, or vice versa.

Radial Inward Flow.—Inlet at periphery and outflow at the center of a circular tank.

Radial Outward Flow.—Inlet at center and outflow at the periphery of a circular tank.

Rainfall Rate.—Precipitation, generally expressed in inches per hour.

Rate of Precipitation.—See **Rainfall Rate.**

Raw Sewage.—See **Crude Sewage.**

Receiving Basin.—See **Inlet Well.**

Regulator.—A device for controlling the quantity of sewage admitted to an intercepting sewer or unit of a disposal plant.

Relative Stability.—The ratio, expressed in percentage, of available oxygen in waste waters, sewage, effluent, or diluted sewage to that required to provide complete bio-chemical oxidation of the organic matters contained therein.

Relief Sewer.—A sewer built to relieve an existing sewer of inadequate capacity.

Reservoir.—A tank or basin primarily for storage of a liquid.

Roof Water.—Storm water from roofs.

Run-Off.—That part of the rainfall which reaches a stream, drain, or sewer.

Run-Off Coefficient.—The ratio, expressed decimally, of run-off to precipitation.

Run-Off Rate.—An expression of the rate at which rainfall runs off from a surface, expressed in inches in depth of rainfall per hour, cubic feet per second, or other units.

Sand Catcher.—See **Grit Catcher.**

Sand Filter.—A filter in which sand is the filtering medium. See, also, **Intermittent Filter.**

Sanitary Sewage.—(1) Domestic sewage with storm water excluded by design. (2) Sewage originating in the sanitary conveniences of a dwelling, business building, factory, or institution. (3) The water supply of a community after it has been used and discharged into a sewer.

Sanitary Sewer.—A sewer which carries sewage and excludes storm, surface, and ground-water.

Saturation.—The condition of a liquid when it has taken into solution the maximum possible quantity of a given substance at a given temperature and pressure, as water saturated with oxygen.

Screen.—A device with openings, generally of uniform size, used to retain coarse sewage solids. The screening element may consist of parallel bars, rods, or wires, grating, wire mesh, or perforated plate, and the opening may be of any shape, generally circular or rectangular slots.

Screening.—The removal of relatively coarse floating and suspended solids by straining through racks or screens made of bars, gratings, wires, or perforated plates.

Screenings.—Material removed from sewage by screens and racks.

Scum.—A mass of sewage solids, buoyed up by entrained gas, grease, or other substance, which floats at the surface of sewage.

Scum Board.—A vertical baffle dipping below the surface of sewage in a tank to prevent the passage of floating water.

Secondary Settling Tank.—See **Final Settling Tank.**

Sedimentation.—The subsidence and deposition of suspended matter in a liquid by gravity.

Sedimentation Tank.—A tank or basin in which sewage, partly treated sewage, or other liquid containing settleable solids, is retained long enough, and in which the velocity is low enough, to bring about sedimentation of a part of the suspended matter, but without a sufficient detention period to produce anaerobic decomposition.

Semi-Circumferential Flow.—Flow parallel to the semi-circumferences of a circular tank, divided at the inlet and meeting again at the common outlet.

Separate Sludge Digestion.—The digestion of sludge in basins or tanks to which it is removed from the basins or tanks in which it originally settled.

Separate System.—A system of sewers in which sewage and storm water are carried in separate conduits.

Sept-Aer-Sed Method.—Sewage treatment in which septic tank effluent is aerated and passed into a sedimentation tank. The sludge from the sedimentation tank is then pumped back into the septic tank.

Septic Sewage.—Sewage undergoing putrefaction in the absence of oxygen.

Septic Tank.—A settling tank intended to retain the sludge in immediate contact with the sewage flowing through the tank for a sufficient period to secure a satisfactory decomposition of organic solids by anaerobic bacterial action.

Settleable Solids.—Suspended solids which will subside in quiescent sewage in a reasonable period. (Two hours is a common arbitrary period.)

Settled Sewage.—Sewage from which some of the solids have settled out in a tank during quiescence or slow flow.

Settling Chamber.—(1) The second or final element of the so-called biolytic tank. (2) Sometimes used to designate the sedimentation compartment of a 2-story tank, as in the case of the Imhoff tank. See, also, **Sedimentation Tank.**

Settling Solids.—See **Settleable Solids.**

Settling Tank.—See **Sedimentation Tank.**

Sewage.—(1) Wash water and water-carried animal, culinary, and, in some cases, industrial wastes. (2) Liquid waste containing human excreta, and other matter, flowing in or from a house drainage system or sewer. Excreta includes feces, urine, secretion from the skin, expectoration, etc. (3) Liquid wastes from dwellings and institutions, stables and business buildings. It may also contain liquid wastes from industries. (4) A combination of (a) the liquid wastes conducted away from residences, business buildings, and institutions, and (b) from industrial establishments, with (c) such ground, surface, and storm water as may be admitted to or find its way into the sewers. (5) The ordinary liquid contents of a sewer containing organic wastes, which may or may not include street wash.

Sewage Disposal.—General term. The act of disposing of sewage by any method.

Sewage Farming.—A term applied to the raising of crops where sewage is applied to the land for irrigation and fertilization purposes. See, also, **Broad Irrigation.**

Sewage Oxidation.—The process whereby through the agency of living organisms in the presence of oxygen, the organic matter is converted into a more stable or mineral form.

Sewage Purification.—(1) The removal or mineralization of all putrescible organic matter and the removal of all infectious and offensive matter. (2) Loosely used for Sewage Treatment.

Sewage Treatment.—Any artificial process to which sewage is subjected in order to remove or so alter its objectionable constituents as to render it less offensive or dangerous.

Sewage Treatment Works.—Treatment plant and means of disposal.

Sewer.—A pipe or conduit, generally closed, but normally not flowing full, for carrying sewage and other waste liquids.

Sewer Appurtenances.—Constructions, devices and appliances other than the pipe or conduit, which are appurtenant to a sewer, such as manholes, flush tanks, surface inlets, etc.

Sewer Arch.—The curved top of a masonry sewer.

Sewer Outfall.—The structure at the lower end of an outfall sewer.

Sewer District.—The area deemed benefited by the construction and use of sewers.

Sewer Inlet.—See **Inlet Well.**

Sewer Territory.—See **Sewer District.**

Sewerage System.—A collecting system of sewers and appurtenances.

Sewerage Treatment Works.—See **Sewage Treatment Works.**

Sewerage Works.—Comprehensive term, including all construction for collection, transportation, pumping, treatment, and final disposition of sewage.

Sheffield System.—A method of activating sludge by the rotation of paddle-wheels placed at intervals in a long and relatively narrow and shallow tank.

Side-Walls.—The vertical, curved, or inclined walls which support the arch or top of a masonry sewer.

Simplex Process.—A process for activating sludge by the circulation of sewage up through a central tube, dispersing it by the rotation of an inverted cone suspended above, and permitting a downward return outside the tube.

Sink Water.—Liquid waste from a sink.

Skimming Tank.—A chamber so arranged that floating matter rises and remains on the surface of the sewage until removed while the liquid flows out continuously under partitions, curtain-walls, or scum boards.

Slant.—A branch inserted in a sewer for the purpose of making connection thereto.

Sleek.—The thin oily film usually present which gives characteristic appearance to the surface of water into which sewage or oily waste is discharged.

Slope.—The inclination of the invert of a sewer expressed in percentage of length, as a decimal, or as 1-ft. fall in a given length of feet.

Slot.—A narrow opening.

Sludge.—The accumulated suspended solids of sewage deposited in tanks or basins, mixed with more or less water to form a semi-liquid mass.

Sludge Bed.—Natural or artificial layers of porous material upon which sludge is dried by drainage and evaporation.

Sludge Cake.—A mass resulting from sludge pressing, or vacuum filtering.

Sludge Chamber.—See **Sludge Digestion Chamber.**

Sludge Compartment.—See **Sludge Digestion Chamber.**

Sludge Concentration.—Any process of reducing the water content of sludge which leaves it still in a liquid condition.

Sludge Conditioning.—Treatment of liquid sludge preliminary to, and to facilitate, de-watering.

Sludge De-Watering.—A general term for the removal of a part of the water in sludge by any process, such as draining, pressing, centrifuging, exhausting, passing between rollers, or acid flotation, with or without heat. It involves reducing from a liquid to a spadable condition rather than merely changing the density of the liquid (concentration) on one hand, or drying (as in a kiln) by high heat on the other.

Sludge Digestion.—The bio-chemical process by which organic matter in sludge is gasified, liquefied, mineralized, or converted into more stable organic matter.

Sludge Digestion Chamber.—(1) Any chamber used for the digestion of sludge. (2) The lower story of an Imhoff tank or Travis tank.

Sludge Drying.—The process of drying sludge by drainage or evaporation, by exposure to the air, or by application of heat.

Sludge-Drying Bed.—See **Sludge Bed.**

Sludge Pressing.—Process of de-watering sludge by subjecting it to pressure, the solids being retained, usually by a cloth fabric through which the water passes.

Spadable Sludge.—Sludge dry enough to be shoveled from the drying bed. (Ordinarily under 70 per cent moisture.)

Spiral Flow Tank.—A tank used in carrying out the activated sludge process in which a spiral motion is given to the sewage in its flow through the tank by the introduction of air through a line of diffusers placed on one side of the bottom.

Spray Nozzle.—See **Sprinkler Nozzle.**

Spraying Nozzle.—See **Sprinkler Nozzle.**

Sprinkler.—See **Sprinkler Nozzle.**

Sprinkler Nozzle.—A nozzle used for applying sewage in the form of a spray to a trickling filter.

Sprinkling Filter.—A trickling filter in which the sewage is applied by spray.

Squeegee.—A device, generally with a soft rubber edge, used for dislodging and removing deposited sewage solids from the walls and bottoms of settling tanks.

Stability.—The ability of any substance, such as sewage, effluent, or digested sludge, to resist putrefaction. (Antonym, Putrescibility.)

Stable Effluent.—A treated sewage which contains enough oxygen to satisfy its oxygen demand.

Stale Sewage.—Sewage containing little or no oxygen, but as yet free from putrefaction.

Stench Trap.—A flap in a frame which opens to admit cellar drainage to a sewer and then closes to prevent sewer air from entering the house.

Sterlization.—The destruction of all micro-organism ordinarily through the agency of heat or of some chemical.

Sterilized Sewage.—A sewage effluent in which all micro-organisms have been destroyed.

Storm Drain.—See **Storm Sewer.**

Storm Overflow.—A weir, orifice, or other device for permitting the discharge from a combined sewer of that part of the flow in excess of that which the sewer is designed to carry.

Storm Overflow Sewer.—A sewer used to carry the excess of storm flow from a main or intercepting sewer to an independent outlet.

Storm Sewage.—Liquid flowing in sewers during or following a period of rainfall and resulting therefrom.

Storm Sewer.—A sewer which carries storm and surface water, street wash, and other wash waters, or drainage, but excludes sewage.

Storm Water.—Excess water during rainfall or continuously following and resulting therefrom.

Storm-Water Drain.—See **Storm Sewer.**

Storm-Water Overflow.—See **Storm Overflow.**

Storm-Water Overflow Sewer.—See **Storm Overflow Sewer.**

Street Sewer.—Common sewer or public sewer in a street. See, also, **Common Sewer; Public Sewer.**

Strong Sewage.—Sewage containing above the normal quantity of organic matter.

Sub-Drain.—A drain built beneath a sewer to intercept ground-water and prevent it from entering the sewer, especially during construction.

Sub-Grade.—The elevation of the bottom of a trench in which a sewer or drain is laid.

Sub-Main Sewer.—An arbitrary term for relatively large branch sewers.

Subsiding Basin.—See **Sedimentation Tank.**

Subsoil Drain.—A land drain deep enough to take water from the subsoil.

Sub-Surface Irrigation.—The process of sewage treatment in which sewage or effluent is applied to land by distributing it beneath the surface through open jointed pipes or drains.

Surface Inlet.—See **Inlet Well.**

Surface Irrigation.—The process of sewage irrigation in which sewage is applied to and distributed over the surface of the ground.

Surface Water.—Water which flows upon or over the surface of the ground.

Surface-Water Drain.—A drain which carries surface water.

Suspended Matter.—Solids physically suspended in sewage or effluent.

System of Sewerage.—See **Sewerage System.**

System of Sewers.—See **Sewerage System.**

Tank.—Any artificial receptacle through which liquids pass or in which they are detained during collection or treatment.

Tight Cesspool.—See **Water-Tight Cesspool.**

Tight Manhole Cover.—A manhole cover without openings.

Trade Wastes.—British expression for industrial wastes. See, also, **Industrial Wastes.**

Trap.—A device to prevent sewer air from backing up and escaping through a plumbing fixture. When made of cast iron or vitrified tile, it may be of various forms defined as running trap, P-trap, S-trap, etc.

Trash.—The material removed from combined and storm-water sewers by coarse racks.

Travis Tank.—A two-story hydrolytic or septic tank invented by Dr. Travis, consisting of an upper sedimentation chamber with steeply sloping bottom terminating in slots through which the deposited solids pass into a lower or sludge digestion chamber through which latter a predetermined part of the sewage is allowed to pass for the purpose of seeding and maintaining bacterial life in the sludge and carrying away decomposition products. This is for the purpose of inducing digestion of the sludge attended by its reduction in volume.

Treated Sewage.—Sewage which has received more or less complete treatment.

Trickling Filter.—An artificial bed of coarse material, such as broken stone, clinkers, slate, slats, or brush, over which sewage is distributed and applied in drops, films, or spray, from troughs or drippers, moving distributors, or fixed nozzles, and through which it trickles to the under-drains giving opportunity for organic matter to be oxidized by bio-chemical agencies.

Trunk Sewer.—A sewer which receives many tributary branches and serves as an outlet for a large territory. See, also, **Main Sewer.**

Twin or Multiple Dosing Tanks.—Twin or multiple tanks of equal capacity, each equipped with a dosing device, which devices are usually so inter-connected that they fill and discharge alternately, or in rotation.

Under-Drain.—A land drain laid below the surface of the ground, or of a sand filter or sludge bed. See, also, **Sub-Drain.**

Ventilated Manhole Cover.—A manhole cover with openings.

Vertical Flow Tank.—A sedimentation tank in which the sewage enters near the bottom, rises vertically, and flows out at the top.

Water-Tight Cesspool.—A cesspool with tight walls to prevent leaching and from which the contents are removed at intervals.

Weak Sewage.—See **Dilute Sewage.**

Wing Screen.—A screen in which the screening elements are radial planes or curved vanes rotating on a horizontal axis.

Maintenance of Sanitary Sewers and Storm Drains

The methods employed on the sewer system of Baltimore, Md., were described in *Municipal News and Water Works* by Milton J. Ruark, Sewerage Engineer, Bureau of Sewers, as follows:

The need for maintaining sewers and drains is usually the result of one or more of four causes: Poor design, poor construction, depreciation, and in some respects the most important of all—misuse.

Poor Design.—The question of the poor design of sewers in Baltimore, where careful study and thought are devoted to relatively unimportant sewer projects, is practically of no importance insofar as the maintenance of the sewers is concerned. Care must be given in selecting the proper materials for construction, and sewers of adequate size and strength should be planned. Except where unusual problems present themselves, the planning of sewers and drains has become so standardized that there is little excuse for poor designs.

Poor Construction.—It is as essential to have good construction as it is to use careful design in order that maintenance costs may be kept at a minimum. Two of the most essential things to watch in the construction of sewers is to see that the material used for backfill is thoroughly compacted under and around the pipe and that the joints are well made. The former precaution will add much to the strength of the sewer, and tend to prevent failures.

A Root Proof Joint.—Tight joints not only reduce the quantity of ground water entering the sewers to a minimum but also help to exclude tree roots. Fully 35 per cent of the chokages in the sanitary sewers of Baltimore are due to the roots of poplar and willow trees. Many times roots grow long distances to reach sewers. The roots of oak and similar shade trees have never been known to give this trouble. In each place where a sewer becomes choked because of tree roots the joints, through which the roots have passed, are remade with great care. First, a ring of jute is inserted in the bell of the pipe the same as when the usual Portland cement joint is made. Then red and puddle clay, to which has been added a liberal quantity of coarse salt, is packed over the jute to within about ½ in. of the end of the bell. On top of this is placed a mortar of cement and sand. This type of joint has proved effective, since none has ever been replaced because of the entrance of tree roots.

Maintenance Due to Depreciation.—The maintenance required to keep a sewer system in first-class condition is usually not great, especially if the system is new. However, there are numerous factors which tend to increase the gradual depreciation of sewers. Other public utilities such as gas and water pipes, electric conduits, etc., are often constructed in trenches adjacent to the sewers, and not infrequently the latter are damaged due to a settlement of earth or other causes. It is sometimes weeks or months before the trouble is discovered and rectified.

The tapping of sewers by plumbers to provide for additional house connections often causes trouble that makes itself evident by a chokage near the tap. One way to remedy this difficulty is to inspect thoroughly every new connection.

A great deal of the general maintenance work consists in replacing noisy and broken manhole covers and making repairs to inlets. Where sewers are well designed and constructed, and are not old, little money need normally be appropriated or spent to remedy wear and tear.

Maintenance Due to the Misuse of Sewers.—Although a sewer system is designed to have a very limited use, it usually becomes the repository for almost conceivable object of moderate size. The following is a list of some of the things which have been removed from choked sewers: Hatchets, bricks, bird cages, corn cobs, flat irons, pick handles, dish pans, shoes, oyster shells, table spoons, broom handles, whiskey flasks, brushes, garden hose, coffee pots, dead cats and dogs, dolls, etc. It seems inconceivable how some of these objects get into the sewers.

Maintenance of Storm Drains.—One of the first rules that must be followed in order to reduce the maintenance of storm drains is to keep the streets clean. Unless this policy is followed the debris on the street is washed into the drains after the first heavy rain, where it often has to be removed at considerable cost.

Furthermore, the material at dumps, the drainage from which flows into the upstream end of storm sewers, should be kept from rolling or obstructing the drains.

Disposal of Snow Into Drains.—In most large cities the disposal of snow into storm drains has become a generally accepted practice. Frequently the snow has mixed with it garbage, ashes and debris found on the streets. The snow melts in the drain and often leaves these foreign materials, which have to be eventually removed, stranded on the bottom of the sewers. Large drains should be selected for the disposal of snow, and liberal quantities of water used for flushing purposes.

Disposal of Oil and Gasoline in Drains.—One of the most serious problems that confronts engineers who have charge of the maintenance of sewerage systems relates to the disposal of gasoline and oil from automobile crankcases into the sewers. The problem is an ever present one not only in Baltimore but also in practically every large municipality in the country. Many cities have had serious explosions because of the ignition of gasoline in the sewers. Some cities employ private concerns to collect and dispose of waste oil and gasoline from garages.

Maintenance of Sanitary Sewers.—The maintaining of the sanitary sewers usually consists of removing obstructions from the smaller pipes—usually 8 and 10 in. in diameter. On rare occasions a 12 in. sewer will become clogged, and only once or twice during recent years has a 15 in. sewer been obstructed. Where the larger sewers require cleaning, it is usually due to wastes from industries.

All obstructions in main line and house sewers up to the building line are removed by the city. On the other hand, chokages in the house sewers inside the property lines are removed by a plumber employed by the property owner. This rule, although a rigid one, is not necessarily adhered to in emergencies. In case the difficulty is due to the carelessness of the property owner he is required to pay for all of the expense involved.

Cleaning Tools.—A wise selection of cleaning tools greatly decreases the cost of maintaining sewers. The first essential is to have good cleaning rods. Two types are used in Baltimore. The rods used to clean out storm drains are made of wood, 3 ft. long, octagonal in shape, and about 2 in. thick. They have the advantage of being strong, and at the same time sufficiently light to float on the water while they are being shoved through the drain.

The other rods, which are used to clean sanitary sewers, are 4 ft. long with a cross-section of 1⅛x⅞ in. Other tools, such as scoops, root cutters, etc., are also of value. One of the greatest time and money saving devices for cleaning sewers has been flexible steel cables. They are narrow but strong ribbons of steel, which are used primarily to clean house sewers. At the end of the cable there are two small steel rollers, which increase the ease with which it can be forced through the sewer. The use of this cable has saved property owners thousands of dollars, which formerly was spent in tearing up and replacing the sewers.

Personnel.—The cleaning of the sanitary sewers and storm drains is under the supervision of one man. As previously stated, there is one gang of five men with a truck which spends all its time in cleaning large storm drains. There are four additional gangs with four men in each gang—each provided with a truck—which clean inlets, report and replace broken and noisy manhole covers and do other work. Each of these gangs is alloted a section of the city which it particularly patrols and is responsible for. There is, moreover, a gang of nine men, which makes repairs both to storm drains and sanitary sewers.

The sanitary sewers are maintained by nine groups of men. Four of these groups, consisting of 18 men and two foremen, relieve chokages on main line sewers, while the remaining five groups, having a total of 10 men and one foreman, relieve house sewer chokages. In addition to the above force there are two men who are on duty on Sundays and holidays and also each day from 4 P. M. until midnight. They take care of any emergency that arises after working hours.

Cost of Sewer Maintenance.—The total cost of maintaining 1,560 miles of sanitary sewers and storm drains during 1927 was approximately $158,000. Of this amount $65,000 was spent on 1,000 miles of sewers and house connections at a cost of $65.50 per mile and $92,500 on 560 miles of drains at about $165 a mile.

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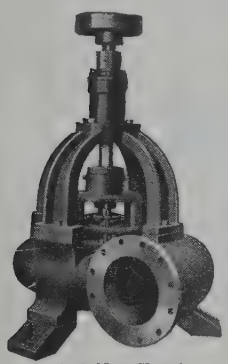

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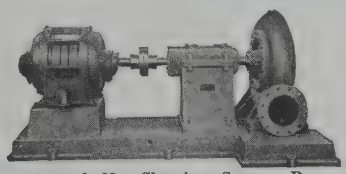

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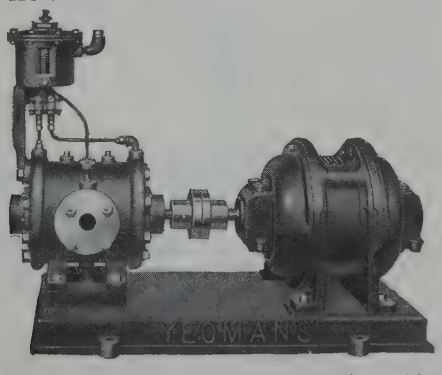

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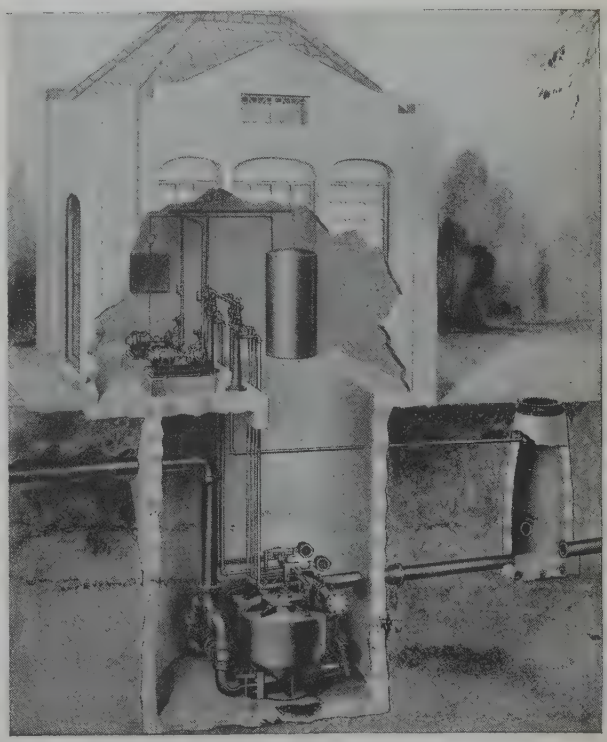
The Shone System of Pneumatic (Screenless) Sewage Ejectors: The oldest and most reliable device on the market for pumping unscreened crude sewage from low-level districts where gravity flow is not obtainable; for effluent or sludge in disposal works; for sewage and drainage from basements below sewer level in city buildings, industrial and power plants, especially where compressed air is required for other purposes. Rotary compressors, shown below, permit operation without storage tank.

The Shone was invented fifty years ago by Isaac Shone, noted English engineer, and since then, with few changes in design, it has been accepted as standard by leading engineers throughout the world.

Among notable installations may be mentioned the city of Cairo, Egypt, in which 63 Shone Ejector stations handle



A Typical Municipal Shone Pneumatic Duplex Ejector Station with Yeomans Rotary Compressors

the entire sewage flow of the city; Rangoon, India, with 13 installations; Bombay, India, 10 installations; Cape Town, South Africa; Rio de Janeiro, Brazil; Ostend, Belgium; Lille, France; Sidney, New South Wales; Moscow and Kiev, Russia; and many other cities.

Operated by Compressed air, the Shone is a purely mechanical device, automatic, sanitary, durable, requiring minimum attention. It has no screens, no storage chambers, no electric float switches. Write for bulletin P-4400.

ALLAN J. COLEMAN

208 North Wabash Ave., Chicago, Illinois

Manufacturers of Sewer Pipe, Closet and Drain Cleaning Tools

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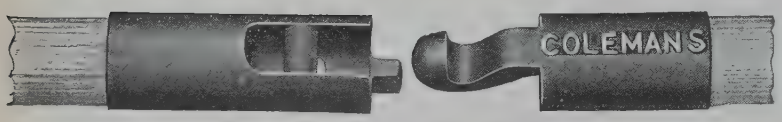
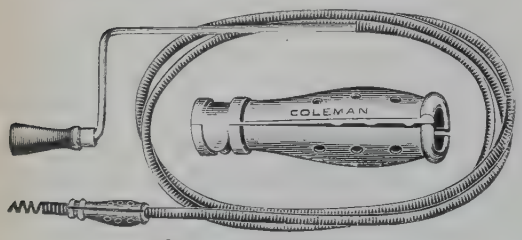


Conduits and Sewer Rods and Tools: Made from the best Hickory Rod. Dia. 1⅛ in., 3 ft. and 4 ft. lengths—Malleable Couplings.



Flexible Coil Wire Pipe Augers, 7 Sizes—All Lengths. With Automatic Grip Handles

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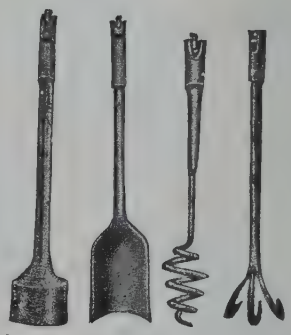
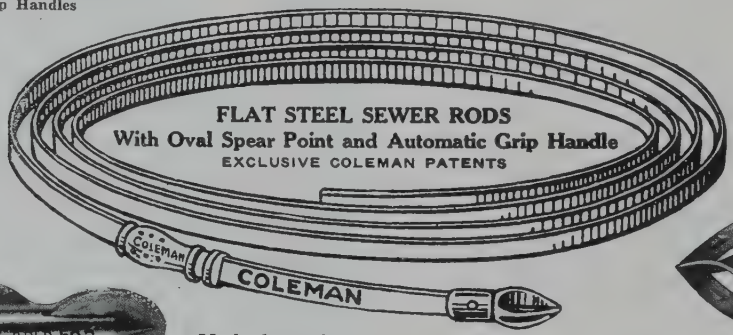


Plunger C-543b **Root Cutter C-543c** **Screw C-543d** **Claw C-543e**

Tools to be used with Conduit and Sewer Rods.

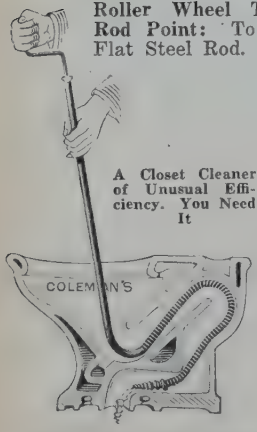
No trouble opening DRAINS if you have these Tools

They will save you money.



Made from the best Spring Steel—six sizes, all lengths—1/16" and ⅛" thick.

Revolving Spear Point: Three sizes to be used with Flat Steel Rod.



Roller Wheel Torpedo Sewer Rod Point: To be used with Flat Steel Rod.

A Closet Cleaner of Unusual Efficiency. You Need It

Illustrated here are a few of COLEMAN'S very useful Closet, Pipe, Sewer and Drain Cleaning Tools.
With these Cleaning Devices it is easy to keep your Pipes and Drains Sanitary.
There are no better tools made for this purpose.
Can be purchased through any supply house.
If they will not furnish our high grade tools—order direct!
You take no chances when you place your order for COLEMAN'S—they are guaranteed to please.

Coleman's Sewer or Basin Dip

COLEMAN'S Lead Joint Runner: All clamps have pouring funnels and asbestos rope. Furnished for all sizes of pipe.

PETERSEN'S HYDRAULIC SEWER FLUSHER CO.

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Factory and Sales Office at 277 First Ave., Milwaukee, Wis.

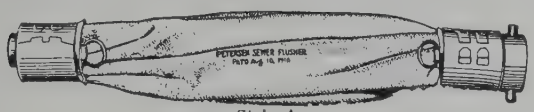
Manufacturers of Sewer Pipe Flushers, Hose Clamps and Equipment

Products: Sewer Pipe Flushers, Hose Clamp and Equipment.

The Petersen Hydraulic Flushers or Expansion Nozzles are Nationally Recognized as the Most Economical Way for Clearing Sewers.

Petersen Hydraulic Flushers eliminate the expense of digging up or taking out drains and will clear a drain in a few minutes.

Connect the FLUSHER to the flushing hose, place it into the drain, any distance desired, the same as an ordinary nozzle. The FLUSHER is very flexible and small, compared to the size of the drain, and will adapt itself to any shape when under pressure, closing up the drain, giving direct water power against the obstructions, preventing the man from getting socked and allow a heavy flow from its nozzle, which fills the drain to the clog. The volume of water



Style A

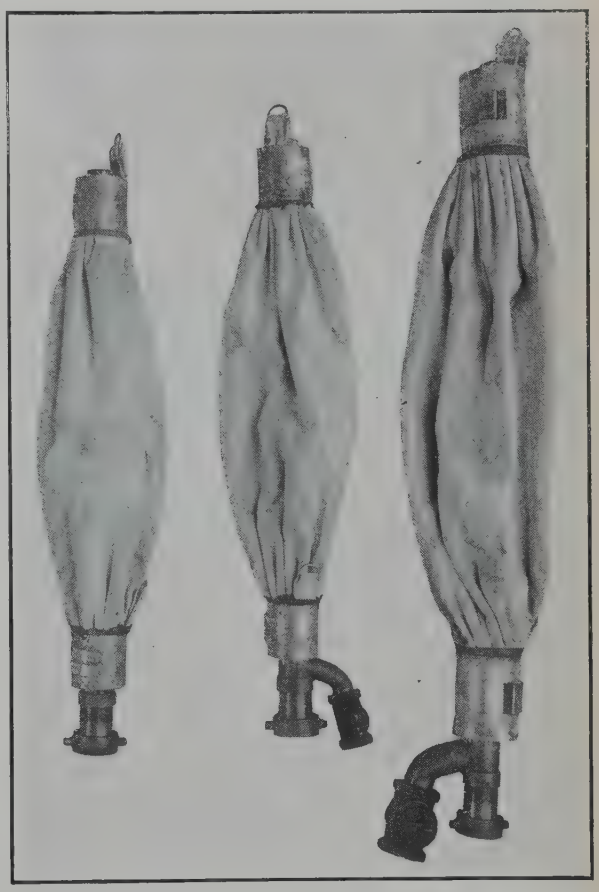
and pressure created removes the obstruction and washes it out. The FLUSHER can also be used to stop the flow of the sewer when repairs are needed.

The Backwater Flush is recommended by many cities using the HYDRAULIC FLUSHER. It is simple. Connect the Flusher to the hose, place the Flusher against the stream in the sewer, turn on the water and it will close up the sewer, then go several blocks upstream, place another FLUSHER and cap the nozzle, turn on the water and you have two streams to raise the water quickly between the FLUSHERS. If you can raise the water a few feet in the manhole, release the first FLUSHER by shutting off the water and open the shut-off which will release the Flusher and empty the water from the hose and bag. For a moment you would believe you had Niagara Falls connected to the sewers and it will be cleared out for many blocks, the MOST MODERN way to clear a sewer.

Style A has a standard hose coupling, or can be furnished in any size coupling. The nozzle is threaded and can be used for a plug by applying a standard 2-in. cap, or reduced when low pressure is used. It is made of heavy grade canvas, 5 ply, a labor saving tool for city, manufacturers and contractors.

Style B has a hose coupling which can be taken off and exchanged with any coupling screw off the shank and the coupling is off and you can place on a new coupling if desired without hurting the flusher. The flusher is made from 6-ply heavy grade canvas and waterproof tubing, from stock number 27 to 29, inclusive.

Style C has an exchangeable coupling which can be taken off. It also has the shut-off. When the instrument is used

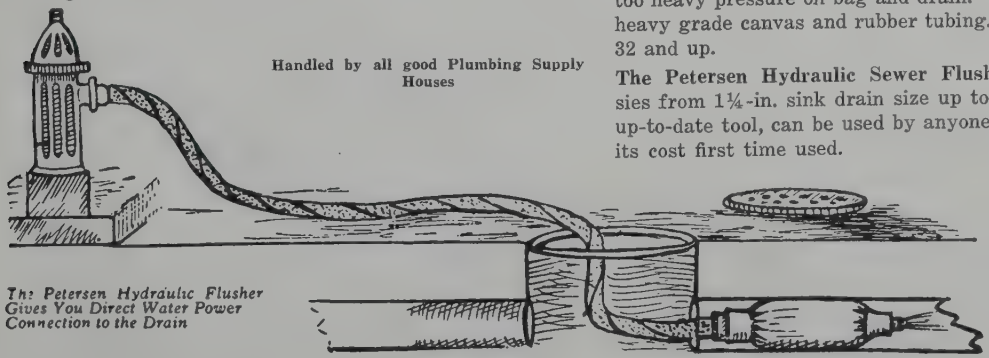


Style B Style C

for a plug, apply a 2-in. cap on the nozzle, open the shut-off and it will release the flow instead of the nozzle, preventing too heavy pressure on bag and drain. It is made from 7 ply heavy grade canvas and rubber tubing. From stock number 32 and up.

The Petersen Hydraulic Sewer Flushers are made in all sies from 1¼-in. sink drain size up to 48-in. It is a strictly up-to-date tool, can be used by anyone and saves more than its cost first time used.

Handled by all good Plumbing Supply Houses



The Petersen Hydraulic Flusher Gives You Direct Water Power Connection to the Drain

If your dealer will not furnish you, order direct.

The Operation of Sewage Treatment Plants

T. C. Schaetzle, Senior Assistant Sanitary Engineer, Maryland State Department of Health, gives the following in *Water Works:*

Sewage treatment plants are installations designed and constructed by man for the purpose of bringing about nature's changes as rapidly as possible, with a minimum of odor and other nuisances, and to prevent pollution of the water courses into which the treated sewages are discharged.

Operator's Duties.—To obtain these two objectives all sewage plants must be run on a strictly business basis. The operator may be likened to a factory manager, the treatment units to the office, machine shop, etc., while the bacterial, chemical and biochemical agents are the "workmen." No business manager would fail for a week, a day, or even an hour to assure himself that all details of the factory operation are receiving proper attention. In like manner, no sewage plant operator can afford to neglect his plant, no matter how small it may be. It must receive daily attention and the sooner those of us connected with this phase of sanitation realize that every sewage treatment unit needs definite daily attention, so that the unseen forces may produce the best results, the sooner will our operating difficulties be lessened.

Designing Engineer's Obligations.—The claim is often made that this or that plant would produce better results if properly operated. While it is true that many plants may not receive the best attention, yet operators have a just cause in their complaint that the engineer designs and builds the plant and then forgets it, never returning to learn how it is funtioning. I believe that the designing engineers could materially help this situation if all of them would attempt to bind their client, be it municipality, industry or institution, to a contract retaining them for a few years to supervise the plant operation.

Furthermore, city authorities frequently have the opinion that when a sewage-treatment plant is installed, the problem is solved and the trouble ended. This is unfortunate, as often the man selected as the operator is underpaid, receives little instruction in his duties, or, in the smaller communities, is assigned to one or more positions, so that the sewage plant work is done mechanically, if at all.

Likewise the average citizen does not know of the existence of a sewage plant, or if he does, it is the last place on earth he cares to visit. Until the citizens and officials show more wholehearted interest in this necessary portion of municipal machinery, we shall continue to secure untrained and underpaid employees. As a result large investments are partly or wholly thrown away due to lack of proper operation.

Meaning of Good Operation.—Good sewage plant operation means the handling of the plant so that each unit performs its specific duty with the highest degree of efficiency. This can be accomplished only by constant and conscientious attention on the part of the operator. Let us consider, therefore, the nature of sewage, the usual processes of treatment, the purpose of each treatment unit and the means of obtaining or at least approaching the end desired.

In order to know the nature of the material to be handled, it might be best to stop for a moment to consider the composition of ordinary sewage. The sewage from a representative American city contains approximately the following constituents:

Solid matter, 200-800 parts per million	divided into	50% mineral of inoffensive material and 50% organic, that is, vegetable and animal matter which is offensive	25% of this is in suspension and 75% in solution whereas 40% of the offensive matter is in suspension and 60% in solution

The mineral matter such as clay and sand is of the least importance, except that it increases the bulk of solids to be handled.

The organic matter is of utmost importance, in fact, the whole sewage treatment operation is devised to arrange for its disposal in the least offensive and most economical manner. Organic matter always contains certain chemical elements (carbon, hydrogen and nitrogen) which change by the process known as decomposition. Decomposition is usually divided into two stages, putrefaction and oxidation.

Bacteria.—In the treatment of sewage these changes usually take place in the presence and through the action of very minute living organisms, so small that they cannot be seen with the naked eye. These organisms are known as bacteria. Roughly speaking, it would take from 5,000 to 20,000 bacteria, placed side by side to make a line 1 in. long. It is these organisms which use the organic matter contained in sewage as their food and in this way break down the complex compounds into simpler and less harmful products.

The air we breathe plays an important part in sewage treatment because it contains oxygen. Whenever oxygen combines with another substance we call the process "oxidation." This process occurs at sewage plants in the trickling filters, contact beds and sand beds. As a definite quantity of the organic matter in sewage requires sufficient oxygen to change it to a stable form, that is, a condition where there will be no further need for oxygen, the efficiency of these devices is measured by the degree to which this matter has been oxidized. As oxygen dissolves in water, it is this dissolved oxygen that is used in the oxidation of sewage.

Putrefaction.—When oxygen is removed from a substance, we call the process reduction. When this process continues far enough to remove all the oxygen present in sewage and no more is supplied, the remaining undecomposed matter will putrefy, that is, develop disagreeable odors.

These two references to chemical reactions are given here only to provide a better understanding of what is to follow and to indicate that there are certain tests available to the chemist, which enables him to determine how his plant is working.

Usual Sewage Treatment Processes.—We are now ready to consider the usual processes of sewage treatment. The first step usually is to remove the very large particles by screens. Then it is passed through tanks to settle out as much as possible of the suspended solids. Where the sewage includes storm water, grit chambers are used to remove the heavier mineral matter. From the tanks, the sewage passes through some type of control apparatus to the filter or oxidizing beds. From here it is not common to resettle the sewage or to treat it with a disinfectant to kill the harmful bacteria. When the activated sludge process is used presedimentation may or may not be used, but the oxidizing beds are omitted.

Screens.—Screening of sewage is accomplished by coarse and fine screens. The former are usually stationary, whereas the latter may be movable or fixed. The object of screening is to remove much floating and suspended matter as would tend to clog the pumping machinery, filter nozzles or any other portion of the sewage plant or to prevent the discharge of unsightly material into the receiving body of water if fairly complete treatment is not given to the sewage.

Operation of Screens.—Screens should be inspected daily to see that they are doing the work expected of them. Fine screens are usually self-cleansing, but the coarse fixed screen must be cleaned by hand. It is well to do this each day, even though the deposit may be small. Care should be taken to prevent pushing some of the larger particles, such as rags, through the openings, as this material may cause difficulties in other portions of the plant. If large quantities of material accumulate, the organic matter held back will soon start to decompose and produce objectionable odors.

The manner of disposing of screenings depends largely upon local conditions, primarily the size of the plant. Burning or burying is usually resorted to. When buried, at least 4 in. of earth cover should be provided.

Grit Chambers.—When sewage contains considerable sand, clay, or similar matter, a grit chamber should follow the screens. This is ordinarily the case when the storm water and household wastes enter the same sewer system. The only function of this structure is to reduce the rate of flow of the sewage to such a point that sand, gravel and other mineral substances will settle out and lighter organic solids will remain in suspension (velocity about 1 ft. per second.)

These chambers should be cleaned after every large storm and in dry weather when the deposited material is sufficient to increase the rate of flow through them to such an extent as to reduce their settling efficiency. If properly designed and operated the deposit should contain little organic mat-

ter. This means it is non-putrescible and inoffensive and can be used for fill, road building, etc.

Like all mechanical equipment the valves and sluice gates of the grit chamber should be examined and oiled at regular intervals to insure ready operation.

Tanks.—Following preliminary treatment, the sewage is subjected to a settling process on one or more types of tanks. The most common forms are the plain settling, septic and Imhoff tanks.

Each of these tanks have one purpose in common, the removal of the solid particles carried in suspension. This is the only function of the plain settling tank. As some of the particles are heavier and some lighter than water, it is evident that by reducing the velocity of flow the lighter particles come to the top and the others sink to the bottom.

In operation these tanks require constant attention. The floating material should be skimmed off at least daily, either by hand or by some mechanical device. The skimmings are usually buried. The time for drawing sludge depends upon the individual tanks. This can be determined by physical and chemical tests, by sounding the sludge depth, or by watching the effluent. The sludge should not be allowed to accumulate so as to reduce materially the active settling portion of the tank and thus increasing the velocity and increasing the solids carried off in the effluent.

The sludge from these tanks should be placed in other tanks known as digestion tanks.

A septic tank is a continuous flow sedimentation tank, which, in addition to removing suspended matter, reduces the volume and weight of the deposited sludge by bacterial action.

When the accumulation of scum or deposited sludge becomes so large that the working area of the tank is materially decreased or the effluent carries an excessive amount of suspended matter, the scum must be removed and the digested part of the sludge placed on drying beds. Either one or both of these operations may be performed at the same time. If more than one septic tank is available, it is good practice to allow the one from which sludge is to be withdrawn to remain idle for a few weeks to permit more complete digestion of the sludge.

Imhoff Tanks.—An Imhoff Tank is a structure which has two stories. In the top, the suspended solids are removed by settling, whereas in the bottom these solids undergo the process known as digestion.

Broadly speaking, digestion is a process by which the organic portion of the sludge is liquefied, gasified and mineralized.

Imhoff Tanks probably are used more extensively at small municipal and institutional installations than any other type of tank. Constant attention is essential. The inlet and outlet channels must be kept clean at all times. All material floating on the sedimentation chamber should be skimmed off daily or oftener, if necessary. The skimmer, as well as a number of other devises referred to in this paper, can be constructed along the lines illustrated in Catalog No. 31 of the Pacific Flush-Tank Co. The walls and sloping bottoms should be cleaned with a squeegee at least twice a week. Care should be taken not to stir the tank contents too much. In reversible tanks the flow should be reversed about every two weeks to insure even deposits of sludge. The slots at the bottom of the sedimentation chamber should be kept open.

The scum in the gas vents should be kept broken up by churning or by means of a water jet so as to allow the escape of gas. Sometimes this scum accumulates to such a depth that it cannot be kept in a semi-liquid condition and must be removed. Foaming occurs at times. The best remedy for this is not known to the writer. Various methods, such as spring with water, drawing sludge frequently in small amounts, and the application of liquid chlorine have been tried with varying degrees of success.

Siudge should never be allowed to accumulate in the digestion chamber so that it is nearer than 2 ft. from the slot at the bottom of the sedimentation chamber. This can be determined by soundings at regular intervals, preferably at least once a month during the open season. The writer has found a weighted circular plate 12 in. in diameter, attached to a wire to be the best sounder. Others prefer sampling with bottles lowered to various depths. This is usually done by attaching the bottle to a pole, lowering it to the desired depth, pulling the stopper with a cord previously attached and finally withdrawing the bottle more or less filled with sludge.

Well ripened sludge should be drawn off into sludge drying beds at intervals varying with different plants. In this state once a month probably is a fair average time interval for the period from April 1 to December 1. Never remove all the well digested sludge. At times, when foaming occurs in the gas vents and gassing brings considerable sludge to the surface of the sedimentation chamber, sludge must be drawn regardless of its condition.

Well digested sludge is almost black in color and has a tarry odor. Undigested sludge is grayish in color, sticky, does not dry well and has an offensive odor.

At many plants it has been a difficult problem to obtain well digested sludge. Several years ago the speaker determined some ratios of the rate and degree of digestion to the amount of seeding material used. It was learned then that the degree of alkalinity or acidity of the sludge had a bearing upon the speed and degree of digestion. Within the past few years, it has been found that the application of lime to sludge and scum to obtain a pH value between 7.3 and 7.6 will produce the best and most rapid digestion of sludge.

The pT scale can be likened to the thermometer scale. On this scale 32° represents the freezing point of water. Any values higher than 32° denotes an increase in heat whereas any values below 32° denote an increase in coldness. In other words, the degree of heat increases as the numbers increase and the degree of coldness increases as the numbers decrease. In like manner the degree of alkalinity or acidity of a solution is expressed by the Hydrogen Iron Scale where we use pH values instead of degrees. At pH 7.0 we have a neutral solution. With a decrease in these figures the acidity of the substance being tested increases whereas with an increase in numbers we have an increase in alkalinity. In other words, if we have a pH of 6.8 we need lime to obtain a pH of 7.3 to 7.6, but not as much as would be needed if the pH were 6.0. The best method or place of applying the lime in actual practice is open for discussion.

Digestion tanks are separate tanks into which plain sedimentation tank or undigested sludge is placed for digestion. The temperature of the sludge in separate digestion tanks or in the sludge chamber of Imhoff Tanks, has a material bearing upon the digestion process taking place therein. A uniform temperature of about 70° F. is beneficial.

Dosing or Control Devices.—Dosing devices are used to control the application of settled sewage to the oxidizing units. At large plants various controls may be employed, but at small plants the automatic sewage siphon usually is used. Only liquid should enter the dosing chamber. This should be drained occasionally and the sides and bottom cleaned, as an excessive accumulation of solids may interfere with the operation of the siphon.

The failure of sewage siphons to operate properly is usually due to one of two causes, namely, an air leak in the bell or some part of the piping connected to the bell, or the clogging of the apparatus.

Oxidizing Device.—The usual oxidizing devices at sewages plants are trickling filters, contact beds and sand filters. The primary object of these units is to add sufficient oxygen to the settled sewage to make it stable, that is, to prevent odor production and to reduce the oxygen demand of this liquid. By accomplishing the latter the production of a nuisance in the body of water into which the sewage plant effluent will discharge may be avoided.

The operation of each of these types of oxidizing devices is somewhat different, but to accomplish their ultimate object, certain attention is required. It is possible of course, to determine their efficiency by chemical tests, to be illustrated this afternoon, but my only purpose here to is to indicate the regular attention these units require.

Trickling Filter.—Although automatic in action the trickling filter needs regular attention. To obtain maximum efficiency of these beds the sewage should be distributed evenly. This means that the nozzles and rinser pipes must be kept clean and free from deposits and growths.

Occasionally pooling occurs on these beds. This usually is due to a greenish growth common to these filters. Pooling should be prevented by keeping the surface of the beds clear of grass, weeds and this green growth. The latter can be removed by flushing with a hose, turning the surface over with forks or rakes, or where possible, by allowing the bed to remain idle for from 24 to 48 hours and then turning on the sewage. By the latter method the dried film washes away easily, but this procedure may

produce objectionable odors. It is claimed that the application of copper sulphate or liquid chlorine will remedy this condition.

During the winter it becomes necessary at some plants to remove the nozzles entirely to avoid freezing. Although this procedure must be followed the nozzles should be replaced as early in the spring as weather conditions will permit.

A disagreeable feature of trickling filters is the breeding of a small moth fly in the top few inches of the stone bed. This can be controlled by flooding the bed. Recently it has been claimed that the breeding of these flies can be controlled also by applying the liquid chlorine every fourteen days to the sewage being sprayed on the bed.

Contact Beds.—The number of contact beds in active use in Maryland is small. It may be well, therefore, to state that, while trickling filters and contact beds are built of stone, the real difference in them lies in the method of operation. With trickling filters the sewage is applied continuously and evenly, whereas for contact beds the sewage is applied, then allowed to remain in the bed for some time and then after emptying, the bed is allowed to remain idle. A representative cycle for contact beds is: one hour filling, two hours standing full, fifteen minutes emptying and approximately four hours resting. The most important feature of operation is to see that the best cycle is determined and then maintained and that the beds are given a complete rest of two days every six or eight weeks.

Sand Filters.—In the operation of sand beds sewage is applied intermittently to the surface of the bed, sufficient time being allowed between doses to let the bed return to its best operating condition by reason of the oxygen drawn into the bed as the sewage seeps through.

In caring for these beds it is always necessary to see that the beds are not dosed too frequently. After once determining the best period between doses, probably not less than 6 hours, this rate should be maintained. When a mat forms on the bed so that the sewage cannot pass through freely this should be removed. Although it sometimes becomes necessary to loosen up several inches of the sand to get good operation the sand should never be turned over without first cleaning off all deposits. Always keep the beds as level as possible and apply the sewage uniformly, giving careful attention to the distributor system. No growth of grass or weeds should be allowed on the beds and heavy wagons should be kept off of them. Repair all wash-ins and broken ventilators at once. Never allow the application of sewage in such a way that it will find its way through holes directly to the underdrains.

Winter operation of sand beds is important. In the late fall the beds should be placed in first class condition. The sand should be ridged and furrowed or placed in piles so that when the first dose of sewage is applied to the bed, the surface of the liquid will freeze and the rest of the liquid will pass through the sand, the sheet of ice being supported by the ridges of piles. Advantage should be taken of the warm days to remove the sludge mat, if necessary. Early in the spring the surface of the sand should be cleaned, the sand loosened and the beds leveled.

Activated Sludge Treatment.—There is a system of oxidizing sewage without applying it to contact beds, trickling filters or sand filters. This process is known as "Activated Sludge" treatment. Sludge in a brown, flocculent condition is thoroughly mixed with the raw sewage by means of compressed air. By this thorough mixing and addition of air the solids in the raw sewage are so changed that they will settle in a second tank and the tank effluent will approach stability.

Much could be said about this method of sewage treatment, but it is enough to state here that this type of plant requires very careful attention. Among the items to be looked after are the mixture of a proper amount of activated sludge with the raw sewage, the adjustment of the proper amount of air added, the cleaning of the settling tanks when needed and numerous problems involved in the handling and disposal of sludge.

Disinfection.—It frequently happens that it is necessary to disinfect a sewage plant effluent to protect a water-course which may be used later as a water supply, by cattle or for shell-fish growing. Perhaps the most effective and economical method of disinfection, or at any rate; the one most in use, is the application of liquid chlorine. A number of details must be cared for on liquid chlorine machines. It is well to mention, however, that a method of determining whether or not sufficient chlorine is being added should be used by all operators. This is a simple test for what is called "residual chlorine." This test was demonstrated yesterday afternoon. Remember to apply an ample amount of chlorine, however, so that the residual chlorine is equal to at least 0.5 p.p.m. after ten minutes contact.

Sludge Treatment and Disposal.—The disposal of the solids removed from sewage by settling, commonly known as sludge, presents a very difficult problem. In the fresh condition it is very offensive. It is usually changed from this condition to an inoffensive or digested condition in the sludge compartment of an Imhoff Tank or in separate sludge digestion tanks. After digestion it is ordinarily applied to sand beds for drying, but at some of the larger plants, filter presses and centrifuges have been used.

For sand bed drying the most efficient operation is obtained by applying the sludge to the beds to a depth not greater than 12 in., but preferably not more than 8 in. The sludge should be thoroughly dried and removed before applying more sludge to the sand bed. Never dig holes through the bed to make the sludge drain more freely, as this leads to dirty sand and not infrequently to clogged underdrains. The addition of aluminum sulphate and to the sludge as it is placed on the bed hastens drying. Do not send undigested sludge to the drying beds if this can be avoided. Prevent contact between sludge and sand or earth embankments at the edge of the sludge layer, as flies breed in earth or sand saturated with sludge liquor.

Miscellaneous.—It is well to have water supplied under suitable pressure at every plant. This helps in breaking up the scum in the gas vents of Imhoff tanks, the removal of the growth on the trickling filters and in keeping the plant generally tidy.

Sewage should never be by-passed around any unit of the plant, except in extreme emergency. If done, a complete record of the time and reason for by-passing should be kept.

Operation Records.—A record of the plant operation should always be kept. Such records will give more intimate knowledge of what the plant is doing. When no laboratory facilities are provided, considerable knowledge of the manner in which the small plant is operating can be obtained by the use of Imhoff cones for estimating the settling efficiency of the tanks, and by the methylene blue test for the determination of the stability of a trickling filter, contact bed or sand bed effluent.

Summary.—To summarize briefly, it has been pointed out that:

1. Sewage treatments plants are constructed for the purpose of changing the organic content of sewage to an inoffensive condition as rapidly as possible, with a minimum of odor and other nuisances, and to prevent pollution of the water-courses into which the treated sewages are discharged.

2. The citizen, official, designing engineer and operator all have a joint responsibility in bringing about successful operation of a sewage treatment plant. The citizen must show more interest, the official must pay better salaries for the more or less disagreeable duties performed by the operator, the designing engineer must not design and forget, but rather keep in touch with the operator to act in an advisory capacity and the operator must be thoroughly and intelligently interested in his work.

3. The operator must realize that he is in charge of an important factory whose processes he must understand. It may produce nothing marketable, but only by proper management will the sewage plant produce a satisfactory effluent and eliminate or reduce the odors at the plant to a minimum.

4. The plant should receive careful, daily attention.

5. No plant is automatic and it will not operate, therefore, without regular attentions. Definite operations, for example, as squeegeeing the sloping walls of the Imhoff tanks, must be performed at definite intervals. Until such regular attention is given to the sewage plant operating difficulties will not be reduced to a minimum.

6. Daily records are essential for best operation.

7. Where no laboratory is available the Imhoff cone test is recommended for a test of the settling efficiency of the tanks and the methylene blue test for the effect of the oxidizing device upon the treated sewage.

8. Where sludge is adjusted by the use of lime to obtain better digestion, the colorimeter pH test is valuable.

9. Whenever disinfection by the use of liquid chlorine is used the test for residual chlorine is essential.

Who Pays for Sewer Taps?

The following was taken from *Water Works:*

Municipal work of all kinds in the State of New York is greatly simplified by means of a coordinating bureau that furnishes information for the guidance of the municipalities of the state. This bureau, the New York State Bureau of Municipal Information, City Hall, Albany, N. Y., headed by W. P. Capes, director, and officered by mayors of various cities and towns in the state, makes a business of assembling and tabulating information on methods ruling municipal work in cities, towns, and villages, and places such information at the disposal of the communities of the state in order that they may be kept up to date on the best methods that may be developed.

Who Pays?—An interesting survey recently completed by the bureau tabulates matters relating to Sewer Taps. The first point displayed by the report is that out of 74 communities listed, 65 require the property owner to pay for sewer taps, 8 stand the cost out of municipal funds, and one, Binghamton, assesses property at $1.00 a foot (50 cents for corner lots) on new sewer work, this assessment giving the owner a connection to the curb line. In this city, if the owner wants a new connection the city carries it to the curb line by city forces and charges for actual labor and material. Another city, included in the 59, not only compells the property owner to defray the cost of the tap, but also charges him the cost of making the cut in the street and of repairing the pavement. The communities making no charge are Corning, Geneva, Hempstead, Johnstown, Lancaster, Middletown, and Watervliet. These latter towns all have a population of under 20,000.

Who Does the Work?—The second question in the survey shows by whom the actual work of connection is done. In fifteen of the communities listed the work of making the connection is done by city forces or by the city under contract. The following tabulation answers the question, "Does the Municipality Do This Work?"

Auburn—In new sewers municipality constructs laterals from main line sewer to city curb. Property owners construct lateral from curb to house. Existing street sewers property owners pay entire cost for house connection and arrange for work to be done. Where new sanitary street sewers are constructed and house connections built to curb line, abutting property owner pay entire cost. The work is done by municipality under contract. Where excavations are made by property owner, city requires the property owner to pay the cost and usually arranges for the work to be done.

Albany—No. The office of the Commissioner of Public Works issues permits free of charge to tap in the sewers. The property owner supervises this work and it is done by plumbing contract.

Albion—No.
Beacon—Plumbers' work.
Batavia—No.
Buffalo—No.
Corning—No.
Cohoes—No.
Cortland—No.
Catskill—Yes.
Dunkirk—No.
East Rochester—Yes.

Elmira—No. City bears the entire cost of trunk line and lateral sewers. It provides "Y" branches for the different property owners, locates such branches when owners wish to connect, makes inspections of such locations but pays for none of the service work.

Fredonia—No. Done by licensed plumbers.

Fulton—No. done by licensed plumbers. If sewer is put in after street is paved, property owner is required to pay, in addition to sewer connection, for repaving the street.

Glens Falls—Yes, from main to curb.
Gloversville—No, done by licensed plumbers.
Geneva—Yes, tap and lay first pipe.
Hempstead—Yes.
Hornell—No.
Hudson—No, done by property owners.
Hudson Falls—No.

Ithaca—No. done by licensed and bonded sewer layer. Inspected by city.

Johnstown—Yes.
Jamestown—Yes.
Kenmore—No. Owner has to pay for opening streets.
Kingston—No.
Little Falls—No.
Long Beach—Yes.
Lackawanna—No.
Lynbrook—No.
Lancaster—No, but city inspects.

Medina—No, but all connections are made under supervision of street superintendent. Whenever permanent pavement is constructed on streets all property owners are notified to make necessary sewer connections.

Mount Vernon—When sewers are laid spurs or "Y" connections are placed at points approximately 25 feet apart, allowing one for each 25 feet on each side of sewer. Cost of this work is assessed against abutting property owners. When the owner is ready to make the connections with the sewer his plumber applies for the permit. This permit costs $5.00 plus the flat rate for opening the pavement. The price of the pavement depends on the type in use.

Mamaroneck—Property owner under supervision of engineers.

Middletown—No.
Malone—No.
Newark—Yes.

Norwich—No. The licensed plumber makes the connection. The city reserves the right to restore all street openings and charge the cost thereof the person to whom the permit is issued.

Newburgh—The municipality does not make flat work connections. The property owner has this work done by his plumber who files a bond with the city to indemnify the city against any loss by reason of the opening of the street in the making of this sewer connection. The only charge by the municipality is where the street has a macadam or paved service. The city does this work and renders a statement of the cost to the property owner which he must pay.

Niagara Falls—No.
New Rochelle—Plumber.

New York City—Owner lays house connection into spur. City only inspects the work.

North Tonawanda—No, done by licensed plumber.

Oneida—No, done by licensed plumber. City lays sewer from main to curb besides tapping main sewer.

Oswego—Yes.

Plattsburgh—Owner does the work and city makes the connections on main sewers.

Penn Yan—City makes tap and supervises other work.
Port Chester—Only when owner fails to do it.
Peekskill—No.
Poughkeepsie—No.
Port Jervis—No, supervises only.
Rome—No, supervises only.

Rochester—No. When sewers are laid laterals are run to lot line to which property owner connects.

Rye—Yes.

Saranac Lake—Village makes the tap and consumer furnishes the material and opens and fills trench. Village lays service pipe from main to curb.

Salamanca—No, city supervises.

Schenectady—Yes, under contract between main and curb. Between curb and house it is installed by plumber engaged by owner.

Sherrill—No.
Syracuse—No.
Scotio—No.
Saratoga—No.
Scarsdale—No.
Seneca Falls—No.
Tonawanda—No.
Tarrytown—No.

Utica—When not done in advance of paving work, city does the work. On paved streets, property owner also pays for restoration of pavement.

Watertown—Yes.
Watervliet—No.
Yonkers—No.

What Charges Are Made?—Another question, relating to the amount charged property owners for the work of making sewer taps and connections, revealed a lack of uniform-

ity in the rates charged and in the method of computing charges. The answers to this question follow:

Binghamton—In replacement of road surfaces city charges owners for labor and material if they desire a connection in a location other than where the original was located.

Beacon—$1.50.

Buffalo—The paving contractor is responsible for the construction of necessary lateral sewer and water connections. These connections are constructed under the supervision and in accordance with directions from the city engineer, the unit rates for same being a part of the contract, but being a special assessment against the property benefited.

Catskill—Labor and materials.

Corning—Property owners pays for relaying of pavement. Plumbers are licensed and bonded and compelled to take out permits to open the streets.

Cortland—None.

Cohoes—$4.40 per square yard for restoring pavement.

East Rochester—Labor and material at cost.

Glen Falls—Dirt streets $17.00; macadam $20.00; paved $42.00.

Jamestown—Actual cost for work and materials up to $25.00.

Kenmore—In dirt or cinder streets 60 cts.; asphalt or brick $20.00; cement $15.00; macadam $5.00; inside of curb, 60 cts.

Long Beach—An average of $15.00 is charged before the pavement is laid. If payment is laid and permit issued to dig up street, the average is $45.00.

Malone—This village has a peculiar situation in that the sewers are not under the supervision of the village, but are owned and maintained by sewer companies or associations, as they were before the village was incorporated, and only give permits allowing work in the streets to be done on them without the actual supervision.

Mamaroneck—Earth or macadam street, $4.00 fee and $25.00 deposit. Paved streets, $4.00 fee and $100.00 deposit.

Newark—Cost plus ten per cent.

New Rochelle—Dirt streets, $7.50; macadamized streets $15.00; penetration macadam streets, $30.00; asphalt and other paved streets, $40.00.

New York City—A charge of $10.00 is made for privilege of connecting to sewer in the Borough of Manhattan. The charge is made for the cost of issuing permit and for cost of restoring pavement if street has been paved. $1.00 is charged for permit and a deposit of $10.00 for 12 square yards, one-half for first restoration and other half for possible second restoration if settlement occurs, actual cost of labor and materials being charged and refund of balance, if any, being made. No charge for opening unpaved streets except for permit.

Ogdensburg—$5.00 is charged. Property owner stands the expense of excavation and back-filling. On paved streets sewers are laid as far as curb before paving.

Oswego—Cost of tile and labor.

Plattsburgh—For earth streets, $5.00; for macadam, $10.00; for paved streets, $25.00.

Penn Yan—$1.00 for tap. Property owner pays all other expenses.

Port Chester—Actual cost.

Rochester—Charge for actual time of inspector on job. If pavement is cut, property owner pays for repairs which are made by city.

Rye—About $1.75 where there is no rock.

Scarsdale—$25.00 for street opening deposit. Repairs made by village and deduction of cost of restoring highway made from deposit.

Sherrill—Property owner pays for sewer when it is laid. He makes tap at his own expense.

Tarrytown—Village makes a charge for street opening based on size and kind of pavement removed. Charges are as follows: Dirt streets, 5 cts. per square foot; macadam streets, 10 cts. per square foot; brick and bituminous macadam, 30 cts. per square foot; concrete and other types at cost.

Utica—Cost varies with depth of sewer and length of line, varying from $55.00 to $90.00.

Watertown—Actual cost plus road cut. Road cuts are as follows: Earth, 50 cts. per square yard; macadam, $2.50 to $3.00 per square yard; pavement, $5.00 per square yard.

Watervliet—$15.00 for dirt, gravel or macadam streets; $20.00 for granite block or other stone surface street without concrete base; $25.00 in concrete, granite block or concrete base or other kindred pavement.

Yonkers—$5.00 per each connected.

Meterage

Setting Meters

The following was taken from a booklet issued by the Buffalo Meter Co.:

Size of Meters.—More than 90 per cent of the service pipes of most water works are ½ in. or ¾ in. and can be metered with ⅝ in. meters. This size is certainly large enough for premises occupied by the average family. Two family flats having a single ¾ inch. or larger service pipe are usually supplied through a ¾ in. meter.

When the meter selected is too large it has several disadvantages; the greatest possible sensitiveness to small leak flows will not be obtained, the first cost of metering the service will be unnecessarily high and the minimum charge for water high if based as usual on the size of the meter. When the meter selected is too small, there will be complaints of lack of pressure and no water, and the overworked meter will be expensive to maintain. Where the minimum charge for water is based on the size of the meter consumers often apply for meters that are too small.

Location of the Meter.—Four different methods are in general use for installing water meters: First, in the cellar; second, buried in the lawn with dial extension; third, in a vault built in the lawn; fourth, in a meter box buried in the lawn.* Some water works officials advocate that particular method which they have adopted, to the exclusion of all others, but each method has some advantages all its own and the best one to employ depends upon the service conditions to be met.

Cellar Setting.—Undoubtedly the great majority of meters are set in cellars. In the business districts of cities, frequently no other location is available as there are no lawns and no earth beneath the sidewalks. This is the least expensive plan for setting meters and it also permits of the consumer reading the meter himself which should certainly be his privilege. The atmosphere in cellars is generally dryer than in out-door vaults and boxes so the registering parts of meters are not so liable to corrode and stick. Heavy snow falls do not prevent reading the meters. The meter should be set horizontally and close to the stop and waste cock so no connection can be made subsequently to the pipe between the meter and the water mains without being detected. Some water works protect cellar meters with a cast iron lock box or with a wooden box having a hinged lid and padlock—such protection is not usually considered necessary.

Buried with Dial Extension.—If a premises has no cellar or there is a hydrant in the front yard the meter must then be set between the street curb and the property line. The meter is set in the direct run of the service pipe and buried; its dial is elevated to the surface of the ground and protected by a cast iron curb box. Many meters are set in this manner and it is the least expensive form of outdoor installation; the meter dial is in the most accessible location for reading without disturbing the consumer; sealing is not usual as there is no chance for tampering; leaks on the service pipe between the meter and the house will be registered; there is less liability of damage from hot water forced or drawn back through the meter and no damage from freezing if the service pipe is below frost line; the meter register is in a position accessible for repairing but if the submerged works of the meter require repairs the meter must be dug up.

Vault Setting.—Another style of outdoor setting consists of a vault extending from the surface of the ground down to the service pipe and covered by a cast iron cap. The walls of the vault may be built of concrete, brick, vitrified sewer tile and even wood. Some water works officials advocate setting the meters in the direct run of the pipe at the bottom of the vault and others prefer elevating the meters about midway by risers; when the latter method is employed keep the meter in the center of the vault and the pipes 4 or 5 in. from the walls of the vault to reduce liability of freezing. If vaults are liable to be flooded by surface water a drain should be constructed to the sewer or the meter dial elevated above high water mark by an extension. Vault settings have many of the advantages mentioned above with dial extension settings and besides provide for quickest removal of the entire meter for repairs.

Meter Box Setting.—There is a variety of cast iron boxes made for protecting meters set out-doors. The construction of these boxes depends upon the climatic conditions under which they are to be used and the ideas of the various manufacturers. The simplest and least expensive consist of an oval, cone-shaped cylinder with the lower end open and the surface end with a cover and lock bolt; this style is generally made 1½ ft. or 2 ft. long for use in warm climates where the pipes are not buried deeply. The meter is set at the bottom of the box in the direct run of the pipe. Other boxes for cold climates are adjustable for pipes buried at different depths; some are water tight and some have special connections for the quick exchange of meters.

Rules for Setting and Starting.—Before cutting the service pipe, flush it thoroughly to remove sediment, sand and gravel which are liable to make trouble if washed into the meter. After cutting and threading the pipe, remove thread-cutting chips from inside the end of the pipe.

If the service to be metered is new a temporary flushing pipe the length of the meter should be placed in the meter couplings and after a few days' use of water the flushing pipe removed and the meter installed.

Do not use paint or joint compound freely on the pipe joints between the meter and the mains as it is liable to wash into the meter and clog the working parts.

Keep the tin caps on the threaded spuds of the meter until the last thing before attaching to the pipes—then blow through the meter to be certain the mechanism is in operative condition.

Disc meters operate successfully in all positions but for best results set them level.

After the meter is set open a faucet and turn the water on slowly so it will gradually expel the air and fill the meter and pipe. Mixtures of air and water under full pressure resulting from not observing this rule are liable to strain and damage the meter's works.

Results of Meterage

Meters Decrease Pumpage and Increase Revenue at Cleburne, Tex.—How the installation of meters decreased the pumpage and increased the revenue at Cleburne, Tex., is well shown in the accompanying diagram from the October, 1925, issue of Water Works. In 1910 there were almost no meters in the system. By 1916 the number installed had

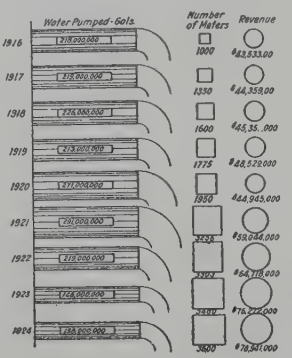


Diagram Showing Pumpage, Meters in Service and Water Revenue at Cleburne, Tex.

reached 1,000 and since had increased to 3,600 in 1924. During the period from 1916 to 1924, inclusive, there was a decrease of 28 per cent in volume of water pumped, and an increase of 81 per cent in revenue. According to the U. S. census Cleburne had a population of 10,304 in 1910 and 12,820 in 1920.

Meterage Reduces Water Consumption 75 Per Cent at Hegewisch.—One of the most remarkable instances of the reduction of water consumption as the result of the installation of meters took place at Hegewisch, a section of Chicago, Ill. According to the 1921 report of the Department of Public Works of Chicago, as noted in *Water Works* for

January, 1923, the installation of the meters brought about a reduction of domestic consumption from 433 gal. per capita to 75 gal. The meters were installed during 1920 on every service, about 850 in number, in the town. A test made on Jan. 31, 1920, showed the total average consumption in Hegewisch amounting to 2,730,000 gal. per day. On Nov. 10, 1920, when the meters were about one-half installed, the total average consumption was 1,640,000 gal. per day. During 1921 these meters were read on different occasions and efforts made to stop the waste and reduce the loss due to leaky plumbing and the use of hopper closets, resulting in further reduction in this section. Final test made on Oct. 20, 1921, indicated an average daily consumption of 620,000 gal. per day, which is less than 25 per cent of the original consumption.

Effect of Metering on Public Health.—One of the stock arguments of opponents of metering is that it will endanger the health of the community by curtailing the use of water for washing, bathing and all household purposes. This, of course, is untrue and cannot be substantiated from health

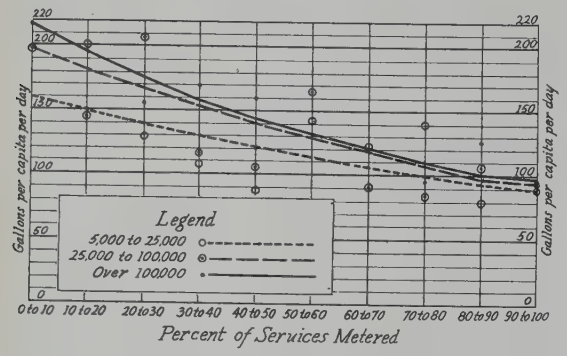


Diagram Showing Effect of Meters on Water Consumption

statistics in any community where general metering has taken place. In 23 cities in the United States ranging in size from 263,500 to 2,859,925, Seattle with a 99 per cent metered service had the lowest death rate (9 per 1,000 inhabitants), while Milwaukee, 100 per cent metered, was the second lowest with 9.8 per 1,000. In Detroit there has been a constantly decreasing death rate with an increasing installation of meters. From the years 1901 to 1911 with 9.1 per cent of the services metered the per capita consumption in Detroit was 138 gal. From 1919 to 1924 with 98 per cent metered the average use was 116 gal. per capita, a reduction or saving in pumpage of 16 per cent.

Data on Metering from 510 Cities.—In a report presented in 1925 to the Commissioner of Public Works of Chicago, Ill. (See Water Works, August, 1925), Maury & Gordon, Consulting Engineers, gave the following table and diagram showing the effect of meters on water consumption:

Effect of Meters on Water Consumption

Percent of Services Metered	Cities 5,000 to 25,000 Population Number of Cities	Gal. per Capita per Day	Cities 25,000 to 100,000 Population Number of Cities	Gal. per Capita per Day	Cities 100,000 Population and Over Number of Cities	Gal. per Capita per Day
0 to 10	60	160.8	16	197.5	3	217.6
10 to 20	20	199.4	3	143.6	3	148.6
20 to 30	17	128.5	2	208.0	3	154.3
30 to 40	15	107.7	4	115.5	3	170.0
40 to 50	8	88.4	5	104.8	3	160.3
50 to 60	18	140.8	5	165.2	0	0.0
60 to 70	18	119.8	4	90.7	0	0.0
70 to 80	16	139.8	10	84.4	4	96.8
80 to 90	31	79.1	9	106.6	10	126.8
90 to 100	145	90.9	53	93.5	22	97.0
Total	348		111		51	

The curves in the diagram represent the average results in 510 cities in the country. The solid black curve shows the average pumpage in cities of over 100,000 population, having various percentages of their services metered. It will be seen that the average pumpage in cities having from 10 to 20 per cent of their services metered is 195 gal. per capita per day. The curve further shows that in large cities having from 90 to 100 per cent of their services metered, the daily per capita pumpage is only 97 gal.

Meterage Results in 150 Ohio Cities and Villages.—A study of meter installations and rates in 150 cities and villages by the State Department of Health of Ohio (See Water Works, December, 1923) showed that for cities and villages with services 100 per cent metered the average daily consumption was 90 gal. per capita and for cities and villages with no metered service the average daily consumption was 170 gal. per capita.

Meter Rates

Some interesting information on meter rates in large cities has been obtained recently by the Municipal Reference Division of the Seattle Public Library at the request of the Water Department of Seattle, Wash. Letters were sent to the Water Departments of the 34 cities of over 200,000 population. Through the courtesy of the Municipal Research Division we are able to print below the results of their investigation:

Eight of the 34 departments did not reply. The latest information available for these cities is included for the sake of completeness, with authority given in each case. Very often the only information available was that given in a similar compilation made by the Seattle Public Library in 1924. "1924 information" refers to the former report.

The population figures are U. S. Census Bureau estimates of 1927 unless otherwise stated.

The percentage of metered sources is taken in most cases from a table compiled by the Chicago City Engineer in 1925 and printed in the recent report of the Chicago Department of Public Works on water waste.

Newark has been omitted as no information concerning that city is available.

Akron, O.—(208,435) 1920 census, no cost. 100 per cent metered. First 20,000 cu. ft. per quarter, $1.60 per 1,000; next 20,000 $1.50 per 1,000; next 20,000, $1.40 per 1,000; next 20,000, $1.30 per 1,000; over 80,000 cu. ft., $1.20 per 1,000. Minimum monthly rates: ⅝ in. meter, $1.20 per mo.; ¾ in., $2.00; 1 in., $3.00; 1½ in., $4.00; 2 in., $5.00; 3 in., $7.00; 4 in., $10.00; 6 in., $15.00; 8 in., $25.00; 10 in., $40.00.

Atlanta, Ga.—(249,000). Maximum rate 20 ct. per 100 cu. ft.; minimum rate, 10½ ct. per 100 cu. ft. Minimum charge per mo., $1.00 for 500 cu. ft. 1924 rate, no later information received.

Baltimore, Md.—(819,000). 18 per cent metered. First 5,000 cu. ft. per quarter, $2.00 per 1,000; next 45,000, $1.00 per 1,000; over 50,000, 75 ct. per 1,000.

(Minimum Quarterly Rates)

⅝	in. meter,	$ 2.00	for 1,000	cu. ft.
¾	in. meter,	3.50	for 1,750	cu. ft.
1	in. meter,	6.00	for 3,000	cu. ft.
1½	in. meter,	10.00	for 5,000	cu. ft.
2	in. meter,	15.00	for 10,000	cu. ft.
3	in. meter,	30.00	for 25,000	cu. ft.
4	in. meter,	50.00	for 45,000	cu. ft.
6	in. meter,	90.00	for 96,667	cu. ft.
8	in. meter,	160.00	for 190,000	cu. ft.
10	in. meter,	225.00	for 276,667	cu. ft.
12	in. meter,	275.00	for 343,333	cu. ft.

Charitable rates: 9 ct. per 1,000 cu. ft. to organizations giving treatment to over two-thirds of inmates; 12 ct. of free treatment to one-third to two-thirds of inmates; 14 ct. of free treatment to less than one-third of inmates; 39c if no free treatment.

Religious rates: 39 ct. per 1,000 ft.

Educational rates: 48 ct. per 1,000 cu. ft.

Boston, Mass.—(793,100). 94 per cent metered. First 20,000 cu. ft. per year, $1.54 per 1,000; next 20,000, $1.43 per 1,000; next 960,000, $1.32 per 1,000; over 1,000,000 cu. ft., per year $0.88 per 1,000. Minimum charge, $8.80 per year.

Chicago, Ill.—(3,102,000). Meter may be installed on request. 60 ct. per 1,000 cu. ft. 15 per cent discount if paid within 30 days. Information J. Chicago City Council 26 Jan. 1927, p. 5353.

Buffalo, N. Y.—(500,000). First 3,000 cu. ft. per mo., $1.00 per 1,000; next 3,000, 70c per 1,000; over 6,000, 40 ct. per 1,000. Minimum meter rate as follows:

Size of meter	Rate per year	Water allowance cu ft.
⅝ in.	$ 12.00	12,000
¾ in.	15.00	15,000
1 in.	20.00	20,000
1½ in.	30.00	30,000
2 in.	40.00	41,714
3 in.	50.00	56,000
4 in.	100.00	169,000
6 in.	200.00	419,000
8 in.	300.00	669,000
10 in.	400.00	919,000
12 in.	500.00	1,169,000

1924 rate. No later information received.

Cincinnati, O.—(401,247.) 98.6 per cent metered. 12 ct. per 100 cu. ft. Minimum charge, 40 ct. per mo. Charitable rates: Free to the extent of 40 gal. per day per person to charitable institutions; half rates (same limit in amount) to institutions partly supported by fees; ¾ rate to churches, gymnasiums and other community welfare organizations.

Cleveland, O.—(972,600.) 100 per cent metered. 60 ct. per 1,000 cu. ft. Minimum semi-annual rates: ⅝ in. meter, $3.00; ¾ in., $7.50; 1 in., $9.00; 1½ in., $12.00; 2 in., $18.00; 3 in., $37.50; 4 in., $60.00; 6 in., $112.50; 8 in., $200.00.

Columbus, O.—(291,400.) 99 per cent metered. P. W. Je. 1926, p. 187. First 25,000 cu. ft. per mo. $1.20 per 1,000 25,000 to 200,000 cu. ft., per mo. $1.15 per 1,000; 200,000 to 2,000,000 cu. ft. per mo., $1.10 per 1,000; all over 2,000,000 60c per 1,000. Minimum charge, 40 ct. per mo. 1924 information with minimum rate as given in Public Works, June, 1926, p. 187.

Denver, Colo.—(289,800.) 2 per cent metered. 1,000 to 15,000 gal. per mo. 17 ct. per 1,000; 15,000 to 30,000, 16 ct. per 1,000; 30,000 to 60,000, 15 ct. per 1,000; 60,000 to 150,000, 13 ct. per 1,000; 150,000 to 315,000, 12 ct. per 1,000; 315,000 to 637,500, 11 ct. per 1,000; 637,000 to 20,000,000, 10 ct. per 1,000; over 20,000,000 gal. per mo., 8 ct. per 1,000. Minimum rate for residence, 25 ct. per month. Minimum rate for business premises, $3.00 per month. No residences are metered. Flat rate for 4-room house, $2.00 semi-annually with 40 ct. additional for every additional 2 rooms.

Detroit, Mich.—(1,334,500.) 99½ per cent metered. First 10,000 cu. ft. per quarter, 65 ct. per 1,000; next 90,000, 50 ct. per 1,000; over 100,000, 40 ct. per 1,000. Minimum charge, $1.25 per quarter. Service charge per year: ⅝ in. meter, $2.40; ¾ in., $3.60; 1 in., $7.20; 1½ in., $14.40; 2 in., $24.00; 3 in., $33.60; 4 in., $43.20; 6 in., $72.00; 8 in., $110.40; 10 in., $158.40; 12 in., $187.20; 16 in., $302.40; 24 in., $532.80.

Indianapolis, Ind.—(374,300.) 30 per cent metered. (Private company.) 1st 700 cu. ft. per mo., 21½ ct. per 100; next 11,300, 14 ct. per 100; next 18,000, 12 ct. per 100; next 20,000, 10 ct. per 100; next 50,000, 8 ct. per 100; next 100,000, 6 ct. per 100. Minimum monthly rates: ⅝ in. meter, $1.50; ¾ in., $4.50; 1½ in., $7.00; 2 in., $11.00; 3 in., $20.00; 4 in., $30.00; 6 in., $50.00. Information from Amer. City Jl. 1926, p. 111.

Jersey City, N. J.—(321,500.) 35 per cent metered. 90 ct. per 1,000 cu. ft. Information from Public Works, Sept. 1926, p. 303.

Kansas City, Mo.—(383,100.) 82.5 per cent metered. First 2,000 cu. ft. 17 ct. per 100; next 2,000, 16 ct. per 100; next 3,000, 15 ct. per 1,000; next 3,000, 14 ct. per 100; next 5,000, 13 ct. per 100; next 5,000, 12 ct. per 100; next 10,000, 11 ct. per 100; next 20,000, 10 ct. per 100; next 50,000, 8 ct. per 100; next 400,000, 7 ct. per 100; all over 500,000, 6 ct. per 100 cu. ft. Minimum charge 50 ct. per month.

Los Angeles, Calif.—(1,200,000, local estimate.) 99 per cent metered. 1st 10,000 cu. ft. per month, 13 ct. per 100; next 40,000, 11 ct. per 100; next 50,000, 9 ct. per 100; all over 100,000, 7 ct. per 100. Minimum charge per month, ⅝ in., ¾ in. or 1 in. meter, $1.00; 1½ in., $1.50; 2 in., $2.00; 3 in., $3.00; 4 in., $4.00; 6 in., $6.00.

Louisville, Ky.—(320,000.) 353 gal. daily or less, 6 ct. per day; 353 gal. per day up to and including first 5,000 gal. daily, 17 ct. per 1,000; then decreasing 1 ct. per 1,000 for each increased 5,000 gal. daily to 8 ct. per 1,000. For all over 50,000 gal. daily, 6 ct. per 1,000. Charitable institutions supplied water free.

Milwaukee, Wis.—(536,400.) 99 per cent metered. 7 ct. per 100 cu. ft. Service charge $2.00 per year.

Minneapolis, Minn.—(447,700.) 100 per cent metered. 8 ct. per 1,000 gal.

New Orleans, La.—(424,000.) 100 per cent metered. Less than 100,000 gal. per mo., 10 ct. per 1,000 gal. All over 100,000 gal. per mo., 7 ct. per 1,000 gal. Service charge per quarter: ⅝ in. meter, 75 ct.; ¾ in., 90 ct.; 1 in., $1.20; 1½ in., $1.80; 2 in., $3.00; 3 in., $4.50; 4 in., $6.00; 6 in., $10.50; 8 in., $18.00; 10 in., $27.00; 12 in., $36.00 One-quarter total consumption, not to exceed 600 gal. per quarter per person, free for sewerage purposes. Information from American City, July, 1926.

New York City—(5,870,000.) 25.7 per cent metered in 1925. 10 ct. per 100 cu. ft.

Oakland, Cal.—(267,300.) 100 per cent metered. (Private company.) First 50,000 cu. ft. per month, 23 ct. per 100; all over 50,000 cu. ft., 19 ct. per 100. Service charge: ⅝ in. meter, 50 ct. per mo.; ¾ in., $1.00; 1 in., $1.50; 1½ in., $2.50; 2 in., $4.50; 3 in., $8.00; 4 in., $12.50; 6 in., $25.00. Subcharge, 10 per cent of charges.

Omaha, Neb.—(219,200.) 97 per cent metered. First 14,000 cu. ft. per mo.; 12½ ct. per 100 cu. ft.; next 36,000, 9 ct. per 100; next 95,000, 7½ ct. per 100; next 1,230,000, 6 ct. per 100; all over 2,230,000 cu. ft., 6 ct. per 100 cu. ft., flat rate for total quantity. Minimum monthly rate, 35 ct.

Philadelphia, Pa.—(2,035,900.) 7.7 per cent metered. Minimum meter rates per year and quantities of water allowed therefor.

½ in. ferrule	$ 8.00	minimum,	8,000 cu. ft.
⅝ in. ferrule	12.00	minimum,	12,000 cu. ft.
¾ in. ferrule	18.00	minimum,	18,000 cu. ft.
1 in. ferrule	32.00	minimum,	32,000 cu. ft.
1¼ in. ferrule	50.00	minimum,	50,000 cu. ft.
1½ in. ferrule	75.00	minimum,	75,000 cu. ft.
2 in. ferrule	130.00	minimum,	130,000 cu. ft.
3 in. ferrule	290.00	minimum,	290,000 cu. ft.
4 in. ferrule	515.00	minimum,	515,000 cu. ft.
6 in. ferrule	1,150.00	minimum,	1,150,000 cu. ft.

All water in excess of this fixed amount, 40 ct. per 1,000 cu. ft.

Pittsburgh, Pa.—(665,500.) 40 per cent metered. First 250,000 gal. per quarter, 18 ct. per 1,000 gal; next 250,000, 16 ct. per 1,000; next 250,000, 14 ct. per 1,000; all over 750,000 per quarter, 12 ct. per 1,000. (Public Works, Sept. 1926.)

Portland, Ore.—(258,288, 1928 census, no estimate.) 100 per cent metered. For the first 20,000 cu. ft. per month, 9½ ct. per 100; all over 20,000 cu. ft., 7½ ct. per 100. Minimum charge, 60 ct. per month.

Providence, R. I.—(280,600.) First 10,000 cu. ft. quarterly, $1.80 per 1,000; next 90,000, $1.20 per 1,000; all over 100,000; 75 ct. per 1,000. Minimum charge, $8.00 per year. 1924 rate. No later information received.

Rochester, N. Y.—(324,500.) 99 per cent metered. First 20,000 cu. ft. or less, per month, $1.35 per 1,000; next 80,000, $1.20 per 1,000; all over 100,000, 75 ct. per 1,000. Minimum charge $1.50 per quarter.

St. Louis, Mo.—(839,200.) 7.7 per cent metered. Use per 6 mo.

For the first	3,000 cu. ft. 15c	per 100.
For the next	3,000 cu. ft. 14c	per 100.
For the next	4,000 cu. ft. 13c	per 100.
For the next	5,000 cu. ft. 12c	per 100.
For the next	10,000 cu. ft. 11c	per 100.
For the next	15,000 cu. ft. 10c	per 100.
For the next	100,000 cu. ft. 9c	per 100.
For the next	260,000 cu. ft. 8c	per 100.
For the next	3,600,000 cu. ft. 7c	per 100.
For the next	4,600,000 cu. ft. 6½c	per 100.
For the next	10,000,000 cu. ft. 6c	per 100.
For the next	18,000,000 cu. ft. 5c	per 100.

Minimum bill, $1.00. Manufacturing rates to consumers of over 60,000 cu. ft. semi-annually; for the 1st 60,000 cu. ft., 10 ct. per 100; next 440,000, 6 ct. per 100; next 500,000, 5½ ct. per 100; for all over 1,000,000 cu. ft., 5 ct. per 100.

St. Paul Minn.—(250,000.) 99.5 per cent metered. First 10,000 cu. ft. per mo., 9 ct. per 100; 10,000-50,000 cu. ft., 6 ct. per 100; 50,000 to 500,000 cu. ft., 4½ ct. per 100; all over 500,000 cu. ft., 3 ct. per 100. Service charge: ½ in., or ⅝ in. meter, $3.00 per year; ¾ in., $4.20; 1 in., $7.20; 1¼ in., $10.20; 1½ in., $13.20; 2 in., $27.00; 3 in., $60.00; 4 in., $120; 6 in., $240; 8 in., $420; 10 in., $600.

San Francisco, Calif.—(576,000.) 100 per cent metered. (Private company.) First 3,300 cu. ft. per month, 28.8 ct. per 100; next 30,000 cu. ft., 25.2 ct. per 100; all over 33,300, 21.6 ct. per 100. Service charge—monthly: ⅝ in. meter, 78 ct. per mo.; ¾ in., $1.20; 1 in., $1.80; 1½ in., $3.00; 2 in., $5.40; 3 in., $9.60; 4 in., $15.00; 6 in., $30.00; 8 in., $48.00.

Seattle, Wash.—(315,312.) 100 per cent metered. 500 cu. ft. or less, 50 ct. per mo.; over 500 cu. ft., 6 ct. per 100 cu. ft. For manufactories, laundries, motors and elevators, water in excess of 30,000 cu. ft., per mo., 4 ct. per 100 cu. ft.

Toledo, O.—(305,400.) First 10,000 cu. ft. per mo. $1.00 per 1,000; next 150,000, 90 ct. per 1,000; next 1,000,000, 70 ct. per 1,000; over 1,160,000, 50 ct. per 1,000. Minimum monthly charge, 80 ct. Information from Toledo City Journal, June 19, 1926.

Washington, D. C.—(540,000.) 86 per cent metered. Minimum rate, $5.65 per year for 7,500 cu. ft. of water. All in excess of this amount, 5 ct. per 100 cu. ft.

Standard Specifications for Cold Water Meters—Disc Type

Adopted June 9, 1921, by the American Water Works Association and September 14, 1921, by the New England Water Works Association

Cases.—All meters shall have an outer case with a separate inner chamber in which the disc operates. The outer case for all 2-inch and smaller meters shall be of bronze composition. Cast-iron frost bottoms may be provided. The outer case for meters larger than 2 inch shall be of bronze composition or of cast iron protected by a non-corrosive treatment.

All meters shall have cast on them in raised characters the size and the model and the direction of the flow through the meter shall be properly indicated. Meters larger than 1-inch shall be designed for easy removal of all interior parts without disturbing the connections to the pipe line.

External Bolts.—All external bolts shall be made of bronze or of galvanized iron or steel. Nuts shall be designed for easy removal after having been long in service.

Registers.—Registers may be either "round" or "straight" reading, indicating in cubic feet or gallons.

All parts of the registers shall be made of non-ferrous material. The maximum indication of the initial dial and the minimum capacity of the register, when indicating cubic feet, shall be as follows:

Size inches	*Maximum indication of initial dial cubic feet*	*Minimum capacity of register cubic feet*
⅝	1	100,000
¾	10	1,000,000
1	10	1,000,000
1½	10	1,000,000
2	10	10,000,000
3	10	10,000,000
4	100	100,000,000
6	100	100,000,000

All dials, including the initial dial, shall be subdivided into ten equal parts. All hands or pointers shall taper to a sharp point. They shall be accurately set and securely held in place.

Register Boxes.—Register boxes and lids shall be made of bronze composition or same material as the top case, with the name of the manufacturer cast on the lid in raised letters. The serial number of the meter shall be plainly stamped on the lid. If required, the serial number shall also be stamped on the case. The lid shall be recessed and shall lap over the box to prevent dirt from accumulating on the glass. The glass shall be inserted from the inside and securely held in place without the use of putty or pins. All register compartments shall be provided with a water-escape hole ⅛ inch in diameter, so placed that the change gear or registering mechanism cannot be tampered with.

Connections for ⅝, ¾ and 1-Inch Sizes.—Spuds shall be threaded ¾, 1 and 1¼ inch respectively, male thread standard pipe size and so threaded that Briggs standard pipe thread ring gages may be screwed on by hand within one thread of through the gage.

Over-all lengths of meters, face to face of spuds, shall be:

Size	*Length*
⅝ inch	7½ inches
¾ inch	9 inches
1 inch	10¾ inches

Couplings shall be made of bronze composition. Nuts shall be tapped ¾, 1 and 1¼ inch respectively, straight thread, standard pipe size and so tapped that Briggs standard pipe thread plug gages may be backed into the nuts by hand, i. e., the size of the thread in the nut is the maximum size of the Briggs plug, but no larger. Tail pieces shall be threaded ½, ¾ and 1 inch respectively, male thread, standard pipe size and so threaded that Briggs standard pipe thread ring gages may be screwed on by hand, flush with the face of the gage.

Over-all lengths of tail pieces shall be:

Size	*Length*
⅝ inch	2⅜ inches
¾ inch	2½ inches
1 inch	2⅝ inches

Connections for 1½ and 2-Inch Sizes.—Spuds shall be tapped 1½ and 2 inch respectively, female thread, standard pipe size, and so tapped that Briggs standard pipe thread plug gages may be screwed on by hand up to the notch on the plug.

Over-all lengths of meters, face to face of spuds, shall be:

Size	*Length*
1½ inch	12⅝ inches
2 inch	15¼ inches

Couplings shall be made of bronze composition. Nuts shall be tapped 2 and 2½ inch respectively, straight thread, standard pipe size and so tapped that Briggs standard pipe thread plug gages may be backed into the nuts by hand, i. e., the size of the thread in the nut is the maximum size of the Briggs plug, but no larger. Tail pieces shall be threaded 1½ and 2 inch respectively, male thread, standard pipe size and so threaded that Briggs standard pipe thread ring gages may be screwed on by hand flush with the face of the gage. 2 by 1½-inch and 2½ by 2-inch standard pipe size malleable iron bushings are to be furnished with 1½-inch and 2-inch couplings respectively. Care shall be taken to see that nuts as above described can be screwed on to the bushings by hand and that the face of the bushings will be sufficiently true and square to provide a proper packing surface.

Over-all lengths of tail pieces shall be:

Size	*Length*
1½ inch	2⅞ inches
2 inch	3 inches

Connections for 3, 4 and 6-Inch Sizes.—Spuds shall be flanged faced and drilled. Companion flanges shall be of cast iron, faced, drilled and tapped. All dimensions, drilling and tapping shall conform exactly to American standard of January 1, 1914.

Over-all lengths of meters, face to face of flanges, shall be:

Size	*Length*
3 inch	24 inches
4 inch	29 inches
6 inch	36½ inches

Seal Wire Holes.—⅝, ¾, 1, 1½ and 2-inch meters shall have register box screws and coupling nuts drilled for seal wire holes. Meters larger than 2 inch in size shall have register box screws drilled for seal wire holes. All seal wire holes shall be not less than 3/32 inch in diameter.

Measuring Chambers.—The measuring chamber for all meters shall be made of bronze composition and shall not be cast as part of the outer casing. It shall be machined with great care and secured in position in the outer casing so that any slight distortion of the casing which might take place under 150 pounds working pressure will not affect the sensitiveness of the meter.

Discs.—Disc pistons shall be made of vulcanized rubber and shall be fitted accurately but freely in their chambers. Vulcanized rubber pistons shall have a metal reinforcement or a thrust roller.

Intermediate Gear Trains.—The intermediate gear trains shall be of such construction as to be easily removed and shall be made throughout of non-ferrous material. Gear spindles may run in bearings bushed with hard rubber, provided the bushings are so constructed that they cannot drop out.

Strainers.—All meters shall be provided with strainers except when self-strained by means of an annular space between the measuring chamber and the external case. Strainers shall be made of non-ferrous materials and shall fit tightly against the wall of the casing. They shall have an effective straining area as large as practicable and at least double that of the inlet.

Registration.—The registration on the meter dial shall indicate the quantity recorded to be not less than 98 per cent nor more than 102 per cent of the water actually passed through the meter while it is being tested at rates of flow within the limits specified herein under "normal test flow limits." There shall be not less than 90 per cent of the actual flow recorded when a test is made at the rate of flow set forth under "minimum test flow."

Size, inches	*Normal test flow limits, gallons per minute*	*Minimum test flow, gallons per minute*
⅝	1 to 20	¼
¾	2 to 34	½
1	3 to 53	¾
1½	5 to 100	1½
2	8 to 160	2
3	16 to 315	4
4	28 to 500	7
6	48 to 1000	12

Capacity.—New meters shall show a loss of head not exceeding 25 pounds per square inch, when the rate of flow is that given in the following table:

Size, inches	*Gallons per minute*
⅝	20
¾	34
¾	53
1	100
1½	160
2	315
3	500
4	1000
6	

Pressure Test.—Disc meters shall be guaranteed to operate under a working pressure of 150 pounds per square inch without leakage or damage to any part.

Workmanship and Material.—Disc meters shall be guaranteed against defects in materials and workmanship for a period of one year from date of shipment. Parts to replace those in which a defect may develop within such period shall be supplied without charge, piece for piece, upon the return of such defective parts to the manufacturer thereof or upon proper proof of such defect.

Rejected Meters.—The manufacturer shall at his own expense replace or satisfactorily readjust all meters rejected for failure to comply with these specifications.

INFORMATION TO BE FURNISHED TO METER MANUFACTURERS WHEN REQUESTED TO SUBMIT BIDS ON DISC METERS

1. Meters shall conform to the Standard Specifications for Cold Water Meters, Disc Type, adopted by the American and New England Water Works Associations.

2. The manufacturer shall state in his bid the type of meter he proposes to furnish, as listed in his catalogue. The actual capacity of each size of meter called for is to be given graphically from 0 pounds up to 25 pounds loss of pressure. If this capacity be stated in the manufacturer's catalogue references may be made thereto.

3. No bid will be considered on meters of a design which has not been listed for at least one year in the catalogue regularly issued by the manufacturer.

4. The method of testing meters shall conform to that recommended by the Committee on Standard Specifications for Water Meters.

5. (a)* The meters are to be accepted on a certificate furnished by the manufacturers that the meters have met the requirements of the Standard Specifications for Water Meters, as adopted by the American and New England Water Works Associations.

(b)* The meters will be tested by the purchaser to determine whether they do or do not comply with the Standard Specifications for water meters adopted by the American and New England Water Works Associations.

6. Registers shall be {round / straight} reading, and shall record in {cubic feet / gallons}

*Sentence (a) is to be used where the purchaser does not have suitable equipment to test the meters. If he has such equipment then sentence (b) is to be used.

EQUIPMENT NECESSARY TO TEST METERS FOR COMPLIANCE WITH REGISTRATION AND CAPACITY REQUIREMENTS AS SET FORTH IN THE STANDARD SPECIFICATIONS FOR WATER METERS

The standard specifications require that meters shall accurately record the flow within certain limits and shall pass a given quantity of water with a maximum loss of pressure. Suitable equipment to make accurate tests must be available before the purchaser should make complaint of meters not complying with the specifications.

The minimum test equipment required for registration and capacity is as follows:

1. A quick-acting valve on the supply pipe through the use of which the flow can be started and stopped without appreciable loss of time.

2. A valve on the outlet side of the meter which can be used to establish the rate of flow desired.

3. Pressure gages connected on both the inlet and outlet of the meter to show whether any material change in pressure occurs during the period of test which would affect the rate of flow. The outlet pipe is to have sufficient head on it so that the meter will always have pressure on its outlet end and preferably not less than 5 pounds per square inch.

4. A measuring device which may be either of the volumetric or weighing type. Whichever is used, the accuracy of determination of the volume or weight of water discharged into the measuring device must be such as to bring the limit of error within one-tenth of 1 per cent. The volume of water passed must be sufficient to cause at least one revolution of the pointer on the initial dial except for test at "minimum test flow" rate. For the latter test, the amount passed shall not be less than one cubic foot.

It is desirable to have available for testing meters a test table and appurtenances which are manufactured by several concerns. Such an outfit would include the equipment enumerated in the preceding four paragraphs.

For the capacity tests, it is necessary to add to the above equipment, two piezometer rings which must be of exactly the same diameter. The piezometer rings must be free from any burrs where the holes are drilled through the wall of the ring and not less than four holes shall be provided, drilled in pairs and on diameters at right angles to one another. The inlet piezometer ring shall be set close to the meter and shall be at a distance of not less than eight diameters from the nearest upstream stock-cock or fitting in the supply pipe. The outlet piezometer ring shall be placed at a distance of not less than eight nor more than ten diameters from the outlet of the meter. The diameter of the piezometer rings and inlet and outlet pipes shall be the same as the size of the meter to be tested. The piezometer rings are to be connected by either rubber or metal tubing to a mercury U-tube. To this U-tube is to be attached an accurate adjustable scale for measuring the differences between the inlet and outlet pressures. Provision is to be made for the complete removal of air from the tubing connected with the U-tube, and the U-tube and the tubing connected therewith are to be so placed that the air will rise to the outlets. Where relatively high flows are to be recorded, it is necessary to read both sides of the mercury column to compensate, as far as practicable, for irregularities in the diameter of the glass U-tube and such readings are to be made as nearly simultaneously as possible to avoid errors due to fluctuations.

TESTS OF METERS RECOMMENDED

The tests to be made on the meter are divided into two classes: 1, Capacity test; 2, Registration test.

Capacity tests are those which test the design of the meter rather than the workmanship thereof. When a meter of a given make has once been tested for capacity it should not be necessary to again test this type of meter unless a change has been made in its design.

The registration tests should be made on each meter, as the results are affected by workmanship and assembly of individual meters. There is no certainty that, because one meter of a given make comes within certain limits of accuracy, another meter of the same make turned out by the factory on the same day will necessarily give similar results. The register furnished with each meter should be used by both the manufacturer and purchaser in making registration tests. Where the purchaser does not have the necessary equipment to test the meters, there should be furnished by the manufacturer a certificate that each meter has been tested for accuracy of registration and complies with the standard specifications in this respect, and that the type of meter furnished has complied with the capacity requirements.

The registration tests recommended are as follows:

All meters should be tested for accuracy of registration within and as near as practicable to the low and high rates given under "Normal Test Flow Limits."

A test at the "Minimum Test Flow" should be made on as many as possible and not less than 5 per cent of the meters. If the results obtained from testing 5 per cent of the meters show that any meter does not comply with the low flow requirement, additional meters should be tested to the extent deemed necessary to make certain that the other meters do comply therewith.

The pressure test should be made on each size of meter furnished of a particular type. This pressure is to be 150 pounds per square inch and the pressure may be furnished through the use of a hand pump or such other method as may be available. Before the meter has been tested by static pressure and also after it has been so tested, it should be tested for accuracy to see whether the meter has been so distorted as to affect registration. It is considered unnecessary to make a pressure test of each size of meter of a given type more than once if satisfactory results are obtained.

If it be possible to give a working pressure test under 150 pounds per square inch then such a test should be applied rather than a static pressure test.

Data on Consumption, Per Cent of Services Metered and Water Rates for Various Cities

From Water Works

City	Population Served 1920	Average Daily Consump. (m.g.d) 1924	Per Cent of Services Metered		Per Capita Water Consumption in gallons per day							Average Water Rate[A] per 1000 gallons		
			Aver. 5 yrs. 1920-24	1924	1920	1921	1922	1923	1924	Average 5 years 1920-24	Probable Present Safe Amt.	Gallons per Month 25,000 (Domest.)	250,000 (Intermed.)	2,500,000 (Mfg.)
New York City, N.Y.	5,663,980[C][D]	789.2[C]	26	25	130.[C]	127.[C]	128.[C]	131.[C]	131.[C]	129.[C]	135[C]	$0.13	$0.13	$0.13
Mass. Metropolitan Dist.	1,213,430[B]	124.10	82	95	105.	95.	94.	97.	95.	97.	100	0.21[L]	0.19[L]	0.18[M]
Detroit, Mich.	1,061,972	183.97	98	99	143.	143.	148.	135.	134.	141.	140	0.10[J]	0.08[J]	0.06[J]
Cleveland, O.	925,283	151.18	98	98	151.7	135.0	137.3	149.6	140.8	142.9	145	0.08	0.08	0.08
Boston, Mass.	751,810[D]	87.68	73	94	125.	112.	110.	113.	111.	114.	115	0.21	0.19	0.18
Milwaukee, Wis.	500,000	69.02	98	99	133.8	122.2	124.5	132.0	125.4	127.6	130	0.10[J]	0.09[J]	0.09[J]
Cincinnati, O.	414,500	48.94	100	100	119.4	114.7	117.0	115.6	115.1	116.4	120	0.16	0.16	0.16
Newark, N.J.	414,216	43.6	94	96	108.2	91.8	95.4	99.8	97.8	98.6	100	0.15[J][K]	0.14[J][K]	0.13[J][K]
Minneapolis, Minn.	380,582	42.77	100	100	98.8	100.0	100.0	107.0	102.5	101.7	105	0.08	0.08	0.08
Kansas City, Mo.	334,193	48.33	81	83	142.6	132.3	138.3	132.5	125.9	134.3	135	0.22	0.17	0.11
Rochester, N.Y.	278,000	26.4	99	99	95.7	96.2	88.8	86.3	85.6	90.5	90	0.18	0.17	0.15
Providence, R.I.	270,472	23.62	94	95	80.	78.5	81.2	86.	83.	82.	85	0.24	0.17	0.11
Toledo, O.	243,164	29.	99	100	104.	101.	109.	106.	102.	104.	110	0.13	0.12	0.11
Columbus, O.	240,000	23.20	99	99	94.1	82.3	83.6	88.5	85.9	86.9	90	0.16	0.16	0.15
St. Paul, Minn.	234,698	20.38	96	98	81.2	80.7	81.6	80.1	72.7	79.3	80	0.09[J]	0.09[J]	0.09[J]
Worcester, Mass.	179,923	16.27	97	98	92.1	82.5	84.5	85.1	84.5	85.7	90	0.20	0.15	0.10
Hartford, Conn.	165,000	16.16	100	100	78.6	76.7	84.1	95.6	88.8	84.8	90	0.16	0.16	0.10
Grand Rapids, Mich.	145,000	15.91	99	99	98.	94.	98.	113.	99.	100.	105	0.09	0.09	0.09
New Bedford, Mass.	131,350	9.71	95	93	78.	71.	71.	77.	67.	73.	75	0.16[J]	0.10[J]	0.10[J]
Springfield, Mass.	130,114[E]	13.52[E]	99	99	96.[E]	90.[E]	87.[E]	91.[E]	89.[E]	91.[E]	95[E]	0.18	0.08	0.07
Fall River, Mass.	124,843	6.79	100	100	51.1	55.3	49.5	54.1	51.9	52.4	55	0.28	0.20	0.14
Lowell, Mass.	112,759	6.54	89	90	63.4	58.0	56.1	54.5	52.3	56.9	60	0.28	0.28	0.28
Yonkers, N.Y.	101,176	13.41[F]	100	100	110.[F]	105.[F]	114.[F]	112.[F]	122.[F]	113.[F]	120[F]	0.21[A]	0.13[M]	0.15[M]
Lawrence, Mass	94,270	4.64	96	97	49.	43.	46.	46.	45.	46.	50	0.20	0.20	0.20
Brockton, Mass	80,206	4.19	100	100	43.3	43.6	43.9	47.3	50.0	45.6	50	0.26[J]	0.16[J]	0.14[J]
Manchester, N.H.	80,000	6.35	83	85	67.7	66.5	68.4	76.2	76.6	71.1	75	0.13	0.13	0.10
Woonsocket, R.I.	48,360	3.01[H]	96[K]	96[K]	53.	50.7	53.8	59.8	-	54.3[H]	60	0.28	0.14	0.10
Madison, Wis.	38,378	4.77	100	100	102.	99.	101.	106.	102.	102.	105	0.12[J]	0.09[J]	0.06[J]
Waltham, Mass.	31,000	2.23	98	100	63.8	63.2	67.2	65 5	65.5	65.0	70	0.22	0.15	0.15
San Francisco, Cal.[B]	506,676	39.31	100	100	71.4	70.3	63.7	62.2	58.2	65.2	65	0.40[J]	0.33[J]	0.30[J]
												(Domest.) 3/4"	(Intermed.) 2"	(Mfg.) 6"

[J] Includes service charge. – Assumed size of meter for stated quantities.

[A] Rates averaged to nearest cent only.

[B] Private company.

[C] Includes supply from both municipal and private works.

[D] Population for July 1, 1920

[E] Data given on basis of population of "Springfield District" only

[F] Consumption in Yonkers high on account of sugar refineries and other manufacturing plants.

[G] For 1923.

[H] Average for four years 1920 - 1923

[I] Weighted average.

[K] Rates for high pressure service are 1/3 higher

[L] Rate for purposes other than manufacturing.

[M] Rate for manufacturing purposes.

H. W. CLARK COMPANY

Manufacturers of Water Works Necessities

Mattoon, Illinois, U. S. A.

"The Sun Never Sets on Clark Products"

Products: Clark Meter Boxes, Meter Couplings, Coupling Yokes, Meter Testers; Service Boxes, Valve Boxes and Housings; Trouble-Finding Instruments; Curb Cock Replacers, Vise for Brass Pipe, Texagon Couplings, Municipal Castings.

The Clark Meter Box (Northern Type): In climates where the winter frosts penetrate the ground, The Clark Northern Meter Box has been the choice of water works men for over twenty-five years. Clark Meter Boxes afford thorough protection from street traffic, from frost, and from tampering. The meter can always be read, and the lock never becomes inoperative, even if it has not been used for years. Meters are read quickly, and provision is made for the ready accessibility for repairs or replacement of meter.

Covers and lids are furnished in sizes for box bodies 15″, 18″, 20″, and adapters for larger sizes. Box Bodies, vitrified earthenware, are furnished in the above diameters and in lengths from 1′ to 3′, or they may be made of concrete by use of the Clark Iron Collapsible Form described in catalog.

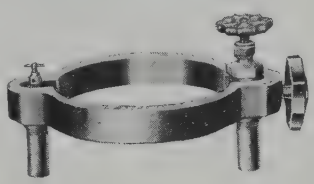
Improved Perfect Lock For Northern Type Lid: The Clark refined and highly developed perfect lock—which keeps the lid tight, yet opens easily—operated by one-third turn of key. Locking Bolt is of one piece construction and is made of forged manganese bronze having a tensile strength of 60,000 lbs.

The Clark Meter Box (Southland Type): For moderate climates, The Clark Southland Meter Box meets every requirement. Made in four cast-iron types and sizes, in round and oval shapes; sheet-iron meter boxes, and rings and lids for use on concrete box bodies.

Improved Wonder Lock (For Southland Box): The refined and highly perfected Wonder Lock for Southern Meter Boxes is of bar and cam construction, assembled without use of screws, rivets or bolts. It is secure, easily operated and always dependable. Bars are of manganese bronze. Key serves as handle and cannot be taken out until Box is securely locked.

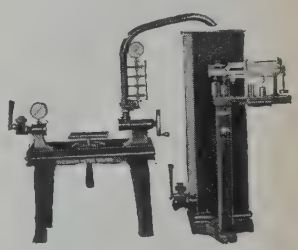
The Aristocrat Key (Long Handled): For use with Clark Southland Boxes and Wonder Lock—the meter reader does not have to stoop over to unlock or lock box or to read meter. A great time saver.

C. M. B. Service Box: Used with or without extension rods. Plug is of cast iron with long screw, one thread to the inch, fitting into bronze bushing. Sliding extension is accomplished by telescoping of intermediate section into base, preventing surface loads or stresses being communicated to cock, which is securely held in a central location, and engagement of wrench is assured.



Meter Coupling Yokes (Circular Type): Because of its circular construction, this yoke combines great strength with light weight and amply provides for contraction or expansion. By removing frame with meter—service is automatically cut off and possibility of unauthorized use of water eliminated.

Meter Testers: Manufactured in eleven sizes, in both single and multiple models in weighing, volumetric or combination types to meet the conditions of every water department, large or small.



Valve Boxes and Housings: Valve Boxes 5¼″ inside diameter. Valve Housings furnished in all-cast-iron construction, and Covers and Lids for use on concrete bodies made by Clark Iron collapsible forms.

Catalogs: The Clark Line of water works necessities is complete and is made up of equipment and accessories that have been developed by practical water works engineers to meet definite needs—and to meet such needs efficiently, economically and in a practical way.

Write for Catalog 27 describing our complete line of Water Works Necessities, also bulletin of Municipal Castings.

READING METER REPAIR COMPANY

Reading, Pennsylvania

Hydraulic Supplies and Equipment for Water Works, Sewerage and Drainage Systems

WATER AND OIL METERS REPAIRED, REBUILT, TESTED

Products: Hydraulic Supplies and Equipment for Water Works, Sewerage and Drainage Systems, Including Meter Testers, Meter Housings, Valve Housings, Curb Boxes, Heaters, Burners, Melting Furnaces, Jointing Materials, Brass Cleaners and Scale Removers, Miscellaneous Water Works Tools, Pumps, Drainage Castings, Valves and Fire Hydrants, Water Works Special Castings and Appliances.

"Reading" Meter Box Covers are exceptionally roomy, permitting removal and replacing of meters without digging; besides, when placed at the curb line, providing space for a stop cock and making a separate curb box unnecessary. Figure B-4 shows a standard meter setting, with a "Reading" Meter Box cover mounted on a section of sewer pipe and enclosing a meter, with stop cock, test tee, combination stop and check-valve and relief valve. By this arrangement no key is required to turn on or shut off the service, meter readings are speeded up and cellar experiences are obviated, thus saving both time and money.

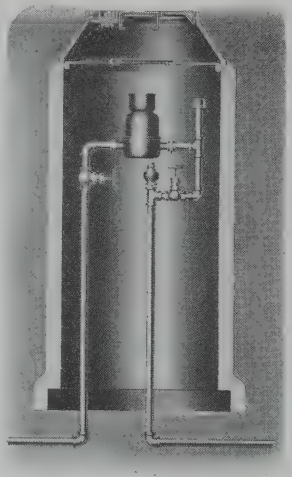


Fig. B-4

The "Reading" Meter Box Cover, Fig. B-1, is not only the most roomy but has the best locked lid on the market. Fig. B-2 shows the specially designed locking device which is operated with the five-cornered socket wrench used on curb box lids. It is interference and fool-proof.

The inner or frost lid, Fig. B-3, which absolutely protects the meter from the cold, is designed to facilitate meter reading.

Gate Valve Housings—the Reading, Non-Breakable, Non-Tilting, Noiseless Gate Boxes

"Reading" Gate Valve Housings are non-breakable, non-tilting, noiseless and of sufficient size to admit a workman, as shown in Fig. C-1. Where these boxes are used there is no necessity for digging up streets to repair valves. These housings are especially valuable where there is permanent paving. A heavy section of metal at the center prevents lids from breaking under heavy loads, and lead gaskets deaden the sound of passing vehicles. Rings care for variations in heights of 1½ in.

"Reading" Curb Box has no projections. There is nothing for the frost to lift and it will remain in place after years of service; in marked contrast to the old style boxes that are lifted whenever the surrounding ground freezes, presenting a menace to pedestrians and an incentive to damage suits. The "Reading" Box is adjustable to any depth of planting. Fig. D-1 shows the "Reading" box complete and D-2 presents a close-up view of the lid and locking device.

"Reading" Combination Furnace is built for melting lead and lead substitutes with wood, coal or coke, or with oil-burning torches. It is constructed of the best quality of heavy cast iron and fully meets all melting furnace requirements.

"Reading" Joint Cement is especially adapted for threading joints of wrought iron and steel pipe, and the other uses to which red lead is usually applied.

"Reading" Brass Cleaner and Scale Remover eliminates the use of acids and an acid room, in the cleaning of bronze or brass castings and the removal of scale incrustations from metal surfaces. Objects cleaned with this solution, without noxious fumes and at a fraction of the cost, are as bright as those on which acids have been used.

Meter Repairing: In the well-equipped Meter Repairing Department, expert and experienced specialists repair, adjust and test water and oil meters of all makes and sizes at moderate cost and with a guarantee of satisfactory functioning.

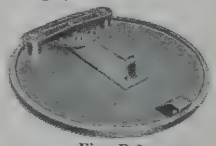


Fig. B-2

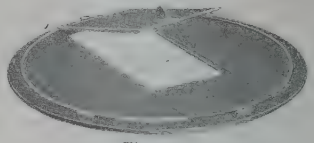


Fig. B-3

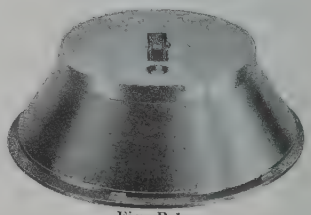


Fig. B-1

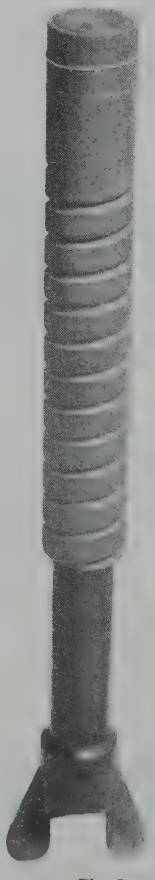


Fig. D-1

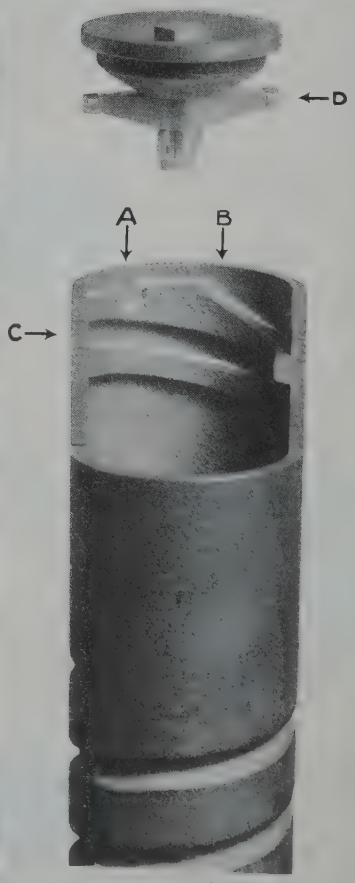


Fig. D-2

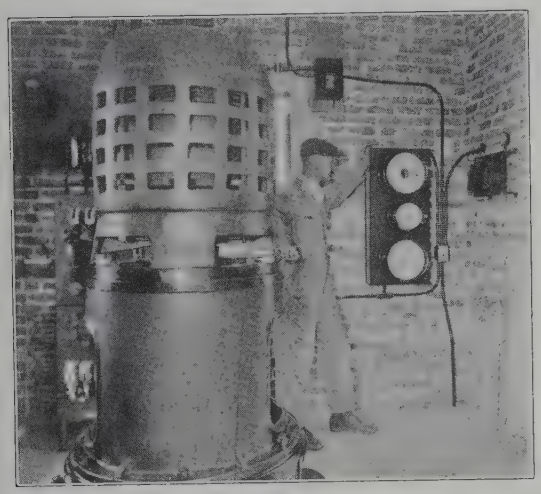
REPUBLIC FLOW METERS CO.

2258 Diversey Parkway, Chicago, Ill.

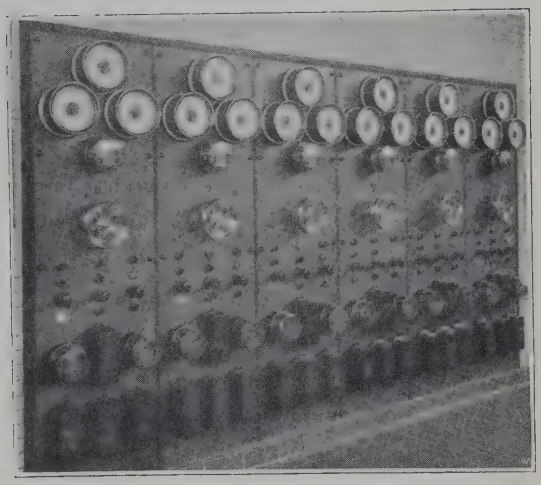
Branch Offices in 25 Principal Cities

Dominion Flow Meters Co., 129 Adelaide St., West Toronto, Canada

Electroflo Meters Co., Ltd., Abbey Road, Park Royal, London, N. W. 10, England



Republic Water Meter on Individual Well Pump—Westmont, Ill.



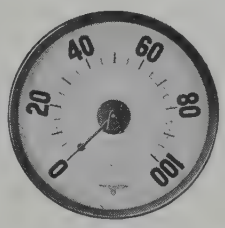
Republic Meters at Detroit High Pressure Pumping Station

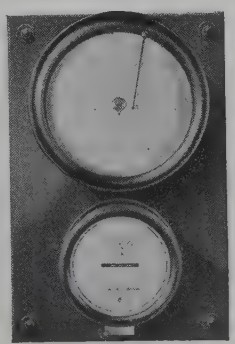
Republic Products: STEAM METERS, WATER METERS, GAS METERS, AIR METERS, CO-2 METERS, PYROMETERS, PRESSURE GAGES, LIQUID LEVEL INSTRUMENTS.

Republic Water Meters have several distinct advantages over any other type of master water meter. The reading instruments being electrically operated, can be placed any distance from the point of measurement. This permits the indicating, recording and totalizing of all flows to be centralized on one panel remote from the individual meters.

Electrical operation permits the control of outlying well pumps from a central control station providing a definite record as to when the pump started and stopped, the number of hours it operated and the total water discharged.

In filtration plants electrical operation permits the reading instruments to be located on the operating table or at any near by or remote point. Only with electrically operated meters is it possible to have simultaneous indications of the washing rate furnished on each control table.





Republic Reading Instruments

The reading instruments can be had in any combination of those shown on the panel at the right, namely: indicating, totalizing and recording.

Republic Advantages

1.—No mechanical moving parts such as levers, cams or floats.

2.—A very small pressure differential is required.

3.—Variation of voltage in current supply does not affect the readings.

4.—Sudden surges of pressure or flow cannot harm meter body.

5.—Foreign matter cannot enter the meter body.

6.—Reading instruments can be located any distance from point of measurement.

7.—Three separate instruments for three distinct types of readings.

Write for bulletin "Republic Water Meter" which contains a complete description of the construction, operation and application of Republic Water Meters.

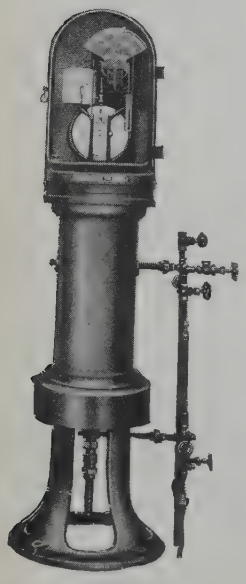
SIMPLEX VALVE & METER COMPANY

6749 Upland Street, Philadelphia, Pa.

SIMPLEX REPRESENTATIVES

American Pump and Supply Company, General Motors Bldg., Detroit, Michigan.
A. F. Barron, 30 North Michigan Blvd., Chicago, Illinois.
C. C. Behney, 718 Empire Building, Pittsburgh, Pa.
Daniel, Inc., 814 Metropolitana Bldg., Havana, Cuba.
M. N. Dannenbaum, Bankers Mortgage Bldg., Houston, Texas.
F. H. Dorner, 311 Knapp Street, Milwaukee, Wisconsin.
Denver Fire Clay Company, Denver, Colorado.
F. Hankin and Co., Ltd., 2028 Union Avenue, Montreal, P. Q., Canada.
F. Hankin and Company, Ltd., 165 Spadina Avenue, Toronto, Ont., Canada.
Kent Engineering Company, 718 Builders Exchange Bldg., Minneapolis, Minn.
Wm. J. Neville, Candler Bldg., Atlanta, Georgia.
O. G. Smith, 110 E. 40th St., Kansas City, Missouri.
Tomlinson, MacLachlan, Inc., 1601 St. Clair Avenue, Cleveland, Ohio.
W. K. Sowdon, Inc., 342 Madison Avenue, New York City, N. Y.
Geo. W. Stetson, 141 Milk Street, Boston, Mass.
W. D. Taulman, Union Indemnity Bldg., New Orleans, La.
Water Works Equipment Co., 149 West 2nd South St., Salt Lake City, Utah.
Water Works & Power Eqpt. Co., White Henry Stewart Bldg., Seattle, Washington.
Water Works Supply Company, 208 Sharon Bldg., San Francisco, Calif.
Water Works Supply Company, Wright and Callender Bldg., Los Angeles, Calif.

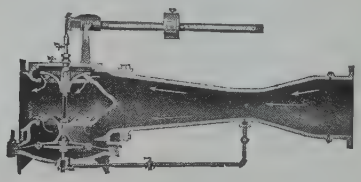
Products: SIMPLEX HOT AND COLD WATER METERS OF THE VENTURI TYPE, PITOT TUBES AND MANOMETERS; ALSO RATE OF FLOW CONTROLLERS; LOSS OF HEAD AND RATE OF FLOW GAUGES; PORTABLE PITOT TUBE CHART RECORDERS; WATER LEVEL GAUGES; AUTOMATIC AIR RELEASE VALVES; AIR AND VACUUM VALVES; PROPORTIONAL CHEMICAL FEED DEVICES, ETC.



Simplex Meter Registers: Are generally operated by venturi tubes; where necessary, are operated by pitot tubes, orifices, etc. They are used for measuring hot and cold liquids under all pressure conditions—for measuring boiler feed, condensate, circulating water, water supply, sewage, brine solutions, anhydrous ammonia, oil, etc. They are noted for their ability to operate under the smallest venturi heads to measure the lowest flows to respond to water differentials from one-eighth inch and upward.

To record each slight definite change in rate of discharge; to operate over the widest range with the greatest accuracy, their design includes an evenly spaced rate of flow dial, a rectangular recording chart, a dependable accurate totalizer and simple means for proving the accuracy of each function with the utmost accessibility and easy for necessary adjustments.

With each instrument is supplied mercury, tools, one year's supply of charts, spare pens, ink, printed instruction bulletin and water manometer testing appliance, by which the instrument may be set exactly correct, and at any time thereafter the correction of this adjustment may be verified.



Simplex Filter Rate of Flow Controllers. An essential device for efficient and safe operation of gravity or pressure type filters, which keep the rate of discharge through the sand bed constant regardless of variation in pressure or

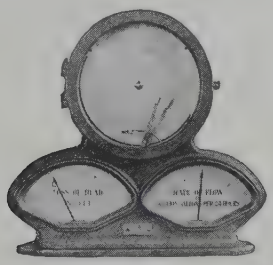
CAPACITIES OF VENTURI TUBES AND SIMPLEX METER REGISTERS

Dia. Pipe, In.	Catalog No. for Ordering	Hot Water (200° F.) pounds per hour		Cold Water gallons per day	
		Maximum	Minimum	Maximum	Minimum
2	2x 25/32	18,150	900	.....	.....
	2x 29/32	24,700	1,250	.....	.....
	2x 1	30,000	1,500	.....	.....
	2x 1 1/16	40,000	2,000	.....	.....
3	3x 1	29,600	1,480	.....	.....
	3x 1 1/4	46,500	2,300	.....	.....
	3x 1 1/2	68,000	3,400	.....	.....
4	4x 1 17/32	69,500	3,500	.....	.....
	4x 1 3/4	92,000	4,600	.....	.....
	4x 2	122,000	6,100	356,000	18,000
5	5x 1 3/4	90,000	4,550	265,000	13,300
	5x 2	120,000	6,000	348,000	17,500
	5x 2 1/2	190,000	9,500	555,000	28,800
6	6x 2 1/2	187,000	9,350	547,000	27,400
	6x 2 3/4	228,000	11,400	665,000	33,500
	6x 3	274,000	13,700	800,000	40,000
8	8x 3	268,000	13,500	780,000	39,000
	8x 3 3/8	340,000	17,000	1,000,000	50,000
	8x 4	485,000	24,500	1,420,000	71,000
10	10x 4	.....	.....	1,400,000	70,000
	10x 5	.....	.....	2,220,000	111,000
	10x 6	.....	.....	3,320,000	166,000
12	12x 5	.....	.....	2,200,000	110,000
	12x 6	.....	.....	3,200,000	160,000
	12x 7	.....	.....	4,480,000	224,000
14	14x 6	.....	.....	3,170,000	160,000
	14x 7	.....	.....	4,360,000	220,000
16	16x 7	.....	.....	4,300,000	216,000
	16x 8	.....	.....	5,680,000	285,000
	16x 9 1/2	.....	.....	8,300,000	415,000
18	18x 9	.....	.....	7,200,000	360,000
	18x10	.....	.....	9,000,000	450,000
20	20x10	.....	.....	8,900,000	445,000
	20x12	.....	.....	13,300,000	666,000
	20x13	.....	.....	16,000,000	800,000

This is a partial list. Specific needs can be filled from the many other sizes available.

vater level. The pressure effect of the water flowing hrough the filter effluent self-operates the controller. It consists of a balanced valve connected to an ample and substantial diaphragm, which is actuated by the difference in pressures due to the low velocity through the body and the high velocity through the throat. This differential pressure is balanced by a counter-weight carried on a beam with knife edge supports. The rate of flow may be changed by sliding the counter-weight.

The Simplex Controller is arranged for either "straight through" outlet (as shown in figure above) or "right hand" or "left hand" outlet as preferred—the Simplex is the original "direct acting, controller."

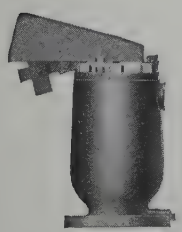


Simplex Filter Gauges: These may be had in many combinations of Indicating Recording and Totalizing, both the Rate of Flow and the Loss of Head.

They are mercury float operated, the Simplex Bell Shaped Float is utilized in the Rate Gauge which provides uniform graduations of flow on both the Indicating Dial and Recording Chart.

There are also available for measuring depth of water in clear wells, sedimentation basis, etc., Simplex water float operated gauges may be furnished in both Indicating and Recording or combined types.

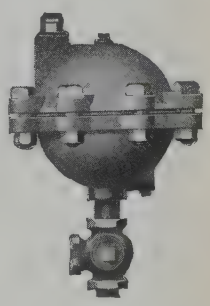
Simplex gauges are dependable, accurate and easily installed—a high grade quality product made with precision and care.



Simplex Valves for Pipe Lines: In the design and operation of large steel pipe lines flowing under gravity, consideration should be given to the possibility of collapse in case, for any reason, the internal pressure is reduced below that of atmosphere. A number of serious failures have been caused by the neglect to provide adequate means to prevent this possibility.

Simplex Air and Vacuum Valves for use on large mains where there is danger of collapse due to vacuum, the valve breaking the vacuum, preventing collapse.
Facilitates the filling of the main, since wide open until full of water.

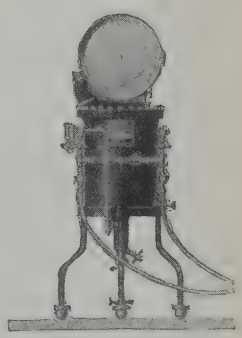
They are made in the following sizes:
2″, 3″, 4″, 6″, 8″, and 10″. The 2″ size is furnished with a screw thread base for nipple connection to the main pipe line. The 3″ to 10″ sizes are designed for a flange connection as illustrated. This may be either low pressure or heavy pressure A. S. M. E. drilling. On the side there is provided a 1″ connection for attaching a Simplex Automatic Air Release Valve whose function is to take care of any small accummulation of air that may be entrapped in a pipe line—if this is not desired a manually operated air vent valve may be used or the top may be plugged. At the bottom on the side there is provided a drain plug.



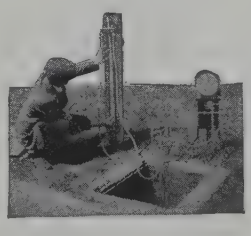
Simplex Automatic Air Release Valves: Nearly every water works superintendent has experienced trouble in connection with some phase of air in pipes. Simplex Automatic Air Release Valves have been designed to release Automatically accumulations of air. They possess the merits of continuous operation without attention, simplicity, compactness, accessibility and low cost, all of which are proved by over fifteen years satisfaction to many users. Located on the high portions of the line, they insure automatic venting of the line and a continuous flow.

Simplex Pitot Tube Recorder: For use with Simplex Round or Flat Pitot Rods—affords not only a record of velocity but can be furnished with pressure elements to give simultaneous readings of velocity and pressure.

This equipment may also be used for Water Waste Surveys or for conducting water flow investigations.



Indispensable to water works engineers for determining character of the flow in the mains of the distribution system.



Simplex Water Waste Surveys: A complete survey service conducted by competent Engineers, with Simplex Pitot Recorder Equipment.

Your inquiry will receive prompt attention and complete recommendations can be furnished.

Who Is Responsible for Water Bill?

The following interesting discussion in the respective responsibility of property owner and tenant for the payment of the bill for water furnished is taken from *Water Works:*

Property Owner Responsible at New Bedford, Mass.—In New Bedford we only recognize the property owner. We are all metered. Some of our large tenement houses have only one meter and the owner pays that bill. If he cares to sub-divide it between his tenants, he can do so by private meters, but, as far as the city is concerned, we look only to the owner for the water that goes into his property. We send our bill to the owner. If he passes it on to his tenant and he pays it, that is all right, but the owner of the property is the man we hold responsible for the charge for water in that property.—Stephen H. Taylor, Superintendent Water Works, New Bedford, Mass.

Property Owner Held Responsible.—In Minneapolis we hold the property owner responsible for all the water bills, although, if we have no mailing address to which to send the bill, it is mailed to the owner or occupant. Our real estate leases in Minnesota provide, the majority of cases, that the tenant pay their own water bills. While the property owner is held responsible, it is a matter of mutual agreement between the tenant and the owner as to which one pays it.—Wm. R. Young, Registrar Water Works, Minneapolis, Minn.

Wisconsin Law Regarding Unpaid Bills.—The state law of Wisconsin provides that any unpaid water bills that are not paid the first of November, are a charge against the property, so that any legislation on this matter must be based on the state law. The state law of Wisconsin provides that any charge whatever, either water bills or repairs on meters are a tax against the property. If those bills are unpaid the first of November, they are to be entered on the tax roll against the property. Our contracts are with the property owner. We have a signed contract with every consumer, that is signed by the owner of the property. The owner of the property owns the meter and is charged with the water bill, if it is not paid by the tenant or the holder of the land contract. That is a state law.—P. J. Hurtgen, Director of Public Works, Kenosha, Wis.

State Law for Lien on Property in Massachusetts.—In Massachusetts, we have a state law for a lien on the property, but you do not have to accept it, if you do not want it. The water department can accept it or not. We accepted it, but we did not want it very badly because our water commissioner's "yes" or "no" in two minutes is law with them. They could shut off or turn on the water if they were so inclined. They could cut off the water in two minutes, advertise your property and sell it. If we have a bad bill we send a man out to shut it off and if a woman gives him a check and the check is no good, he does not take any other check. There is a law in Massachusetts that, if you issue a bad check you go to jail, so there is no chance of a bad check. We allow them therefore to collect the bill.—Patrick Gear, Superintendent Water Department, Holyoke, Mass.

Property Owner Responsible at Sioux City, Ia.—We have 16,000 consumers in Sioux City and are 100 per cent metered. We hold the property owner responsible under our ordinances. In a city the size of ours we found in the last two years that a great many double houses, which formerly supplied two families, are being changed into flats, kitchenettes, etc. A great many of the larger houses are changed into duplexes. It is not practical for two meters and we insist on only one meter. We had it out with the real estate board some years ago. They were quite intent upon making the tenant responsible and letting the water department carry on a profit and loss system for their tenants. After discussing it for some time I wrote thirteen points for them showing why it was impractical. The landlords said the most expensive water they had would be the hot water. One tenant would use it one day and another another day. In the sprinkling season of the year, the sprinkling was done from one service and they could not separate it. There was so many objections to it, that they decided they would have to make it a matter between the landlord and the tenant. Our law makes it a lien against the property. It has been very rigidly enforced. For example, the department of education has some blocks where there were tenant houses. We knew nothing of it for some time and they allowed the tenants to remain. The tenants lately vacated the premises and we sent the bills to the department of education. They tried to repudiate them, but the city attorney said they were obliged to pay them for they were a lien against the property.—Phil. Carlin, Superintendent Water Works, Sioux City, Ia.

Owner Must Sign Contract.—In Wildwood, N. J., the owner must sign a contract and it is a lien against the property. We serve two other municipalities and the owner must sign for the water where it is not a lien against the property. We issue our bills the first of the year for the minimum charges. If they are not paid, we do not bother with them, but, in the other municipalities, we give them 60 days and at the expiration of that time if they do not pay, we give them a ten days' notice. It must be paid within that time or it is shut off without further notice. We make up an account in the form of districts. The man who makes the turn-off has the amount of the bill plus 1 per cent penalty a month. He must get the money at that time or shut off the water. In Wildwood, proper, where they owe a bill, where it is a lien against the property, we do not bother.—Wm. G. Banks, Newark, N. J.

Tenant Pays Bill in Most Cases.—We have 8,500 consumers. We do not hold the property owner responsible, except for properties where there are two meters. The tenant pays the water bill in most cases. The owner may, if he wishes to. We have no contact with the tenant. We require a deposit of $3.00 from each tenant, which is, of course, refunded if they move to some house where they do not use city water. We find that that works very nicely. We read our meters daily and bill daily, that is, we make bills delinquent fifteen days after the bills have been sent out. They receive then a second notice giving them ten days further extension. If the bills are not paid within that time, a shut-off ticket is made out and the water is turned off. They have the right or the privilege to pay the turn-off man with a dollar penalty, before the water is turned on.—McEvoy, Dubuque, Ia.

Lien Law in Pennsylvania.—In Pennsylvania the municipally owned plant has a right within three years after the bill comes due, to declare a lien upon the property for it. I do not know of a case where it has been done, for two reasons; in the first place, we can shut off the water and the landlord will pay to get the water turned on. The second reason is that the constable's fee is rather heavy. Here is always a question of whether you are justified in spending five or six dollars to collect a water bill of an equal amount. The tenants can pay the water bill if they want to. We send all our water bills by mail on a government postcard that costs us about a cent and a quarter for the card and the postage. On the face of it, it is addressed to the tenant or owner, and on the back is marked for the owner or the tenant. Either may pay it. In the last analysis it is the owner who has to pay the bill.

Advantages of Dealing with the Property.—In St. Paul we have properties standing in the name of an owner whose ownership ceased several years ago. New owners are paying the bill and we do not find more than a quarter of them that will take the trouble to come in and change the name on the records to indicate that they are the present owners. That is the advantage we have in saying that we are dealing with that property. We are interested in this property and want it to pay this bill. We cannot go into research concerning the responsibility of the present tenant, the former tenant or landlord or anything of that kind.—C. M. Crowley, Water Registrar, St. Paul, Minn.

Water Works Accounting

Uniform Classification of Accounts

Accounting may be defined generally as a procedure relating to the assembly and recording of facts in business transactions in an orderly, chronological manner, so that periodical statements may be rendered, showing the financial position of any business enterprise and the results from operation; and may be considered as the right hand of management or administration.

Uniform Classification of Accounts.—The National Association of Railroad and Utilities Commissioners have provided a uniform classification of accounts which were revised November, 1922, and goes into the matter of utility accounting in a very comprehensive manner, and up to 1925 a total of 25 states had adopted completely, or nearly so, this uniform classification. Nine commissions have no jurisdiction over this accounting; one has adopted the Federal Power Commission's classification and twelve more have the classification under consideration.

Value of Uniform Classification of Accounts.—One of the principal advantages of uniform accounting is that proper comparisons could be made in financial statements and where a holding company has interests in many states, it is very evident that a uniform classification is desirable. The California Water Service Company reports to the Federal Water Service Corporation of New York under the national association of railway and utilities classification, according to R. B. F. Chisholm, Secretary, California Water Service Co., San Francisco, Calif., in *Municipal News and Water Works*, while their accounts and records are carried under the California classification of accounts as prescribed by the commission. If the California commission could be persuaded to adopt the national association classification, it would, of course, result in considerable saving to their company.

Uniform Accounting.—Uniform accounting for water utilities can best be expressed through uniform classifications of accounts, but uniform classifications of accounts do not necessarily result in uniform accounting, as different accounts may classify items under entirely different heads. For this reason it is desirable that water utility officials get together for conference and in committees to iron out points of departure and arrive at an understanding as to just what each account heading shall include.

The following list of accounts was taken from the instruction book on Uniform System of Accounts for Water Utilities issued by the New Jersey Board of Public Utility Commissioners. This system follows the recommendations adopted by the National Association of Railroad and Utility Commissioners.

Water Utilities List of Accounts

BALANCE SHEET ACCOUNTS

ASSET ACCOUNTS

Fixed capital in water department
Fixed capital in other departments
Construction work in progress
Materials and supplies
Cash
Notes receivable
Accounts receivable
Interest and dividends receivable
Other current assets
Special deposits
Prepayments
Investments
Re-acquired securities
Sinking funds
Amortization fund
Other special funds
Unamortized debt discount and expense
Property abandoned
Other suspense
Corporate deficit

LIABILITY ACCOUNTS

Funded debt
Receiver's certificates
Notes payable
Advances from other corporations
Consumers' deposits
Other accounts payable
Unearned revenue
Taxes accrued
Interest accrued
Other accrued liabilities
Dividends declared
Other unfunded debt
Contributions for extensions
Amortization reserve
Contractual reserves
Unamortized premium on debt
Premium on capital stock
Casualty and insurance reserve
Miscellaneous reserves
Other unadjusted credits
Capital stock
Corporate surplus

FIXED CAPITAL ACCOUNTS

I. INTANGIBLE FIXED CAPITAL

Organization
Franchises
Other intangible capital

II. LANDED WATER CAPITAL

Water diversion rights
Reservation land
Other source of supply land
Purification system land
Pumping system land
Storage reservoir land
Other distribution system land
Miscellaneous landed capital

III. WATER COLLECTING SYSTEM

Reservation structures
Impounding reservoirs
Lake and river cribs
Springs and wells
Infiltration structures
Collecting reservoirs
Intakes and supply mains

IV. PURIFICATION SYSTEM

Settling basins
Coagulating basins
Softening and iron removal plant
Filters
Ozone sterilizing and aeration plant
Chemical treatment plant
Clear water basins

V. PUMPING SYSTEM

Hydraulic power structures
Pumping station structures
Boiler plant equipment
Steam power pumping equipment
Hydraulic power pumping equipment
Electric power pumping equipment
Other power pumping equipment
Miscellaneous pumping equipment

VI. DISTRIBUTION SYSTEM

Transmission mains and accessories
Storage reservoirs, tanks and standpipes
Distribution mains and accessories
Service pipes and stops
Meters, meter boxes and vaults
Fire hydrants and fire cisterns
Fountains, troughs and other equipment

VII. MISCELLANEOUS PROPERTIES

General structures
General equipment
Other tangible water capital

VIII. UNDISTRIBUTED CONSTRUCTION EXPENDITURES

Engineering and superintendence
Law expenditures during construction
Injuries and damages during construction
Taxes during construction
Interest during construction
Miscellaneous construction expenditures

INCOME ACCOUNTS

Operating revenues
Operating revenue deductions

NON-OPERATING REVENUES AND DEDUCTIONS

Rents accrued from lease of water plant
Miscellaneous rent revenues
Interest revenues
Dividend revenues
Miscellaneous non-operating revenues
Non-operating revenue deductions

INCOME DEDUCTIONS

Interest accrued on funded debt
Other interest deductions
Rent for lease of other water plant
Miscellaneous rent deductions
Amortization deductions
Miscellaneous deductions from income

APPROPRIATION ACCOUNTS

Miscellaneous credits to surplus
Expenses elsewhere unprovided for
Dividends on capital stock

Miscellaneous appropriations
Other deductions from surplus

OPERATING REVENUE ACCOUNTS

Metered private service
Unmetered private service
Service to other systems
Municipal hydrant service
Other muncipal service
Miscellaneous water service
Miscellaneous operating revenues

OPERATING EXPENSE ACCOUNTS

I. WATER COLLECTING EXPENSES

Collecting system expenses
  Collecting system wages
  (a) Collecting system superintendence
  (b) Collecting system labor
  Other collecting system expenses
Water purchased
Collecting system repairs
  (a) Repairs of reservations
  (b) Repairs of impounding reservoirs
  (c) Repairs of lake and river cribs
  (d) Repairs of springs and wells
  (e) Repairs of infiltration structures
  (f) Repairs of collecting reservoirs
  (g) Repairs of intakes and supply mains

II. PURIFICATION SYSTEM EXPENSES

Purification expenses
  Purification wages
  (a) Purification superintendence
  (b) Purification labor
  Purification supplies and expenses
Purification system repairs
  (a) Repairs of settling basins
  (b) Repairs of coagulating basins
  (c) Repairs of softening and iron removal plant
  (d) Repairs of filters
  (e) Repairs of ozone sterilizing and aeration plant
  (f) Repairs of chemical treatment plant
  (g) Repairs of clear water basins

III. PUMPING SYSTEM EXPENSES

Station wages
  Station superintendence
  Station labor
  (a) Boiler plant labor
  (b) Steam pumping labor
  (c) Hydraulic pumping labor
  (d) Electric pumping labor
  (e) Other pumping labor
  (f) General station labor
Fuel for power
  Steam pumping power
  Other power fuel
Power from other sources
  Steam pumping power
  Electric pumping power
  Other pumping power
Other pumping expenses
  (a) Water for steam or gas
  (b) Lubricants for pumping
  (c) Other station expenses
Pumping system repairs
  Repairs of hydraulic structures
  Repairs of station structures
  Repairs of pumping equipment
  (a) Boiler plant repairs
  (b) Steam pumping repairs
  (c) Hydraulic pumping repairs
  (d) Electric pumping repairs
  (e) Other power pumping repairs
  (f) Miscellaneous pumping repairs

IV. DISTRIBUTION SYSTEM EXPENSES

Distribution expenses
  Water storage and distribution
  (a) Distribution superintendence
  (b) Storage reservoir labor
  (c) Other distribution labor
  (d) Other distribution expenses
  Work on consumers' premises
  (a) Consumers' meter expenses
  (b) Consumers' installation expenses
Distribution system repairs
  Repairs of storage reservoirs
  Repairs of mains and accessories
  (a) Repairs of transmission mains
  (b) Repairs of distribution mains
  (c) Repairs of consumers' services
  (d) Repairs of fire hydrants and cisterns
  (e) Miscellaneous distribution repairs
  Repairs of consumers' meters

V. COMMERCIAL AND NEW BUSINESS EXPENSES

Commercial expenses
  (a) Commercial office salaries
  (b) Meter reading and collecting
  (c) Other commercial expenses
Business promotion
  (a) Promotion salaries
  (b) Promotion expenses

VI. GENERAL AND MISCELLANEOUS EXPENSES

Administration expenses
  Salaries of general officers
  Other general office salaries
  General office supplies and expenses
Law expenses
Injuries and damages
Insurance
Relief department and pensions
Water franchise requirements
Regulatory commission expenses
Store and transportation expenses
  (a) Store expenses
  (b) Transportation expenses
Miscellaneous general expenses
Miscellaneous adjustments—balance
  (a) Undistributed adjustments—balance
  (b) Duplicate water charges—Cr.
  (c) Water expenses transferred—Cr.
  (d) Joint operating expenses—Cr.
Repairs of general structures
General amortization
Taxes
Uncollectible water bills

Billing and Collecting Methods in a Small City

W. D. McKay, secretary, Water and Light Department, Brainerd, Minn., explains system in article for *Municipal News and Water Works.*

Some six years ago or more I introduced at Brainerd, Minn., a system which has worked very satisfactorily. It saves the expense of mailing bills to our customers, and in addition gives them the amount of their bills, as soon as meter is read.

The city has both water and light plants, and both meters are read at the same time, which is done monthly. There are about 5,000 meters, and two readers require about 21 days each month to read them. Our city is 100 per cent metered.

Blank No. 1 is used by the readers, and is filled out at

Water and Light Department

CITY OF BRAINERD

Telephone 66

Date of Reading_____ 192

Present this at the Office of the Secretary when payment is made.
Office Hours: 8 A. M. to 5 P. M. except
Paydays, when Office is open to 8 P. M.

Name_____

Street and Number_____

METER READINGS

Class	Readings	Consumption	Amount Dollars	Amount Cts.
Light	Present Previous			
Water	Present Previous			
Heat	Present Previous			
Power	Present Previous			
Sprinkling	Present Previous			
		Total		

NOTICE

Rules and Regulations for Customers

All rentals are due and payable at the office of the Secretary before 20th day of month following reading.

If rentals are not paid when due, a penalty of 10 per cent will be added and the city reserves the right to discontinue service without furher notice.

Parties moving into premises must report at once to the office of the Secretary, so that meter readings can be taken, and also ascertain whether previous month's rent has been paid, otherwise they will be held liable for said rent.

It will be appreciated if Office is notified of any leaks in streets or of any Arc Lights out of Commission.

Rules and regulations governing the system are printed and a copy will be furnished on application if you have none.

Blank No. 1

Schedule of Water Rates

All consumers up to 40,000 Gals, 50c per 1,000 Gals. From 40,000 Gals. up to 100,000 Gals. $20.00 per month minimum.
Over 100,000 up to 199,000 Gals. per month, 18c per 1,000 Gals.
Over 199,000 up to 299,000 Gals. per month, 14c per 1,000 Gals.
Over 299,000 up to 399,000 Gals. per month, 10c per 1,000 Gals.
Over 399,000 up to 700,000 Gals. per month, 8c per 1,000 Gals.
Minimum, 75 cents per month.

Sprinkling Rates

Sprinkling rates are governed by the April reading, and run continuously for five months. All used during this time in excess of April reading will be 10c per 1,000 Gals. Minimum of 1,500 Gals. per month for 75c. Sprinkling only applies beyond consumption of 1,500 Gals.

Electricity Rates

Light 6½ cents per K.W.H.
Power—First 500 K.W.H., 4 cents per K.W.H.
Power—Next 250 K.W.H., 3½ cents per K.W.H.
Power—All over 750 K.W.H., 3 cents per K.W.H.
Cooking—3 cents per K.W.H.
Minimum for Light, 75 cents per month.
Minimum for Cooking, $1.00 per month.

Minimum on Power

$1.00 per H.P or fraction thereof up to 5 H.P 25c per H.P or fraction for all over 5 H.P

Back of Blank No. 1

ORIGINAL

Water & Light Dept. Nº 9107

CITY OF BRAINERD

Date of Reading.....8/22/28...192.

Present this at the Office of the Secretary when payment is made
Office Hours: 8 A. M. to 5 P. M., except Paydays,
when Office is open to 8 P. M.

Name ...J. Jones.....

Street and Number .....324 N 8thst.....

METER READING

CLASS		READINGS	CONSUMPTION	AMOUNT Dollars	Cts.
Light	Present	2647	30	1	95
	Previous	2617			
Water	Present	280000	3100	1	55
	Previous	276900			
Heat	Present	1552	52	1	56
	Previous	1500			
Power	Present	1000	740	10	40
	Previous	260			
Sprink'g	Present				
	Previous				
		Total		15	46
		Penalty			
		Total			
		Adjustment			
		Total			
		Paid on Account			
		Balance			

NOTICE

Rules and Regulations for Customers

All rentals are due and payable at the office of the Secretary before 20th day of month following reading.

If rentals are not paid when due, a penalty of 10 per cent will be added and the city reserves the right to discontinue service without further notice.

Parties moving into premises must report at once to the office of the Secretary, so that meter readings can be taken, and also ascertain whether previous month's rent has been paid, otherwise they will be held liable for said rent.

It will be appreciated if Office is notified of any leaks in streets or of any Arc Lights out of Commission.

Rules and regulations governing the system are printed and a copy will be furnished on application if you have none.

Blank No. 2

once and left with the consumers. They have a ready table to make it from, thus avoiding errors. The meter books are audited before bills, as shown in Blank No. 2, are made out from them in duplicate. These bills are filed in a cabinet in street and numerical order, so that customers can be handled very promptly, as it simply requires stamping date of payment. One of these bills is original, the other a duplicate, with perforation between. They are not separated until payment is made. The duplicate is used for our Consumers' Register. Frequently before we used this system, claims would be made that the consumer had paid the previous month, but when we had the original that was evidence enough to know, without any further reference, it had not been paid. These duplicates are a great means also of determining our delinquencies readily, and aid very materially in our trial balances.

Reading water meters monthly enables us to keep in close touch with their condition, as we own all meters.

Municipal Water Department Accounting

The requirements for a municipal system was outlined in *Water Works* by W. C. Hail, senior municipal accountant, League of Kansas Municipalities, Lawrence, Kan. as follows:

The object of this article will be to present, in a general way, what may be considered the more important requirements of an adequate municipal water department accounting system. All forms suggested herein are subject to modification to meet local conditions or to meet the personal ideas of those in charge of the records.

Primarily a water department is interested in its actual cash receipts and expenses, for it is these items that determine the element of profit and loss. It is therefore apparent that the individual customer accounts and other cash transactions should be recorded through separate ledgers.

Customer's Ledger.—The customer's ledger account form, when properly designed, will carry the following information:

Meter readings by month; amount used; charges; arrears; penalty-discount; amount due; date paid and amount paid. It should also carry the customer's name, address and account number, as well as a meter description (meter number, make, size and location).

A meter reader reports the readings, usually by routes covering a given district. The meter slips should cover a year period, showing the present and previous month's reading; the customer's name; his address and the account number. From this slip the bill is made out on a coupon receipt card. Such cards are then set up in numerical account number order and are posted to the customer's ledger record.

Subsidiary Deposit Ledger.—A majority of utilities operating in Kansas require a meter deposit as a guarantee of prompt payment of bills. A subsidiary customer's deposit ledger should be carried, showing on the debit side, the account number, the name and address of depositor, date and amount of deposit received. On the credit side should be shown the date and amount of refund.

Service rendered by the water department to other city departments, such as fire hydrant service, water furnished to flush sewer lines, water supplied for city parks, swimming pools, etc., should be paid for by transfer from proper revenue funds to the utility. Cash receipts from water sales, meter deposits, and their sources should be entered through the ledger accounts suggested, to a distribution cash collection register.

Distribution Ledger.—A well-designed distribution ledger will provide for necessary classifications of receipts and disbursements. The disbursement side should be designed to serve as a warrant register. This ledger may carry any number of account numbers desired. As the volume of business increases there is a general tendency to increase the account numbers, and if this is carried too far, there is danger of swamping the records with details. However, thoroughness and completeness should not be sacrificed in the desire for simplicity. Such classifications of receipts and disbursements should be closed into a general ledger account.

Other ledger accounts necessary for a water department, include: Asset account, liability account, and a reserve for depreciation. These accounts are needed in making up the balance sheet which reflects the true financial condition of the plant.

The asset account includes:

Current Assets

Cash
Accounts receivable

Capital Assets

Real estate
Buildings
Plant machinery and equipment
Wells, pumps and motors
Transmission line
Reservoirs
Service line mains
Meters and meter installations
Fire hydrants
Supplies in warehouse
Other equipment

The liability account includes:

Accounts payable
Waterworks bonds
Reserve for depreciation
Reserve for meter deposits

The cost of furnishing water may be generally grouped as follows:

General Expense

Salaries of superintendent and inspector
Salaries of bookkeepers
Printing and office supplies
Telephone, express, postage
Insurance
Miscellaneous

Operating Expense

Pump and plant wages
Fuel
Oil, waste, packing
Chemicals
Miscellaneous

Distribution and Maintenance

Wages of outside men
Maintenance of high or low pressure stations
Maintenance of distribution system
Maintenance and miscellaneous equipment
Automobile expense
Small tools and repairs

Capital Outlays and Depreciation

Expansions and extensions
Pumping and purifying plants
Mains and hydrants
Meters and meter supplies
Lands and buildings
General equipment
Reserve for depreciation

Production Data.—Production data is important and essential for rate making purposes. The following table is given to show the items used in making up a monthly statement:

Operating Cost for Month

Operation of pump plant
Distribution and maintenance
General expense
Bond interest
Depreciation of equipment

Production for Month

Total gallons pumped for master meter
Sold consumers
City buildings
Parks
Street sprinkling
Sewers
Total accounted for
Water not accounted for
Per cent loss

Cost Per Thousand Gallons Computed on Amount of Water Pumped

Operation
Distribution
General
Bond interest
Depreciation

Cost Per Thousand Gallons Computed on Amount of Water Accounted For

Operation
Distribution and maintenance
General
Bond interest
Depreciation

The importance of frequent reports should not be overlooked. The preparation and distribution of financial reports affords one of the most valuable opportunities connected with the work of an accounting officer. Officials preparing such reports must bear in mind that clearness, brevity, and completeness are essential elements.

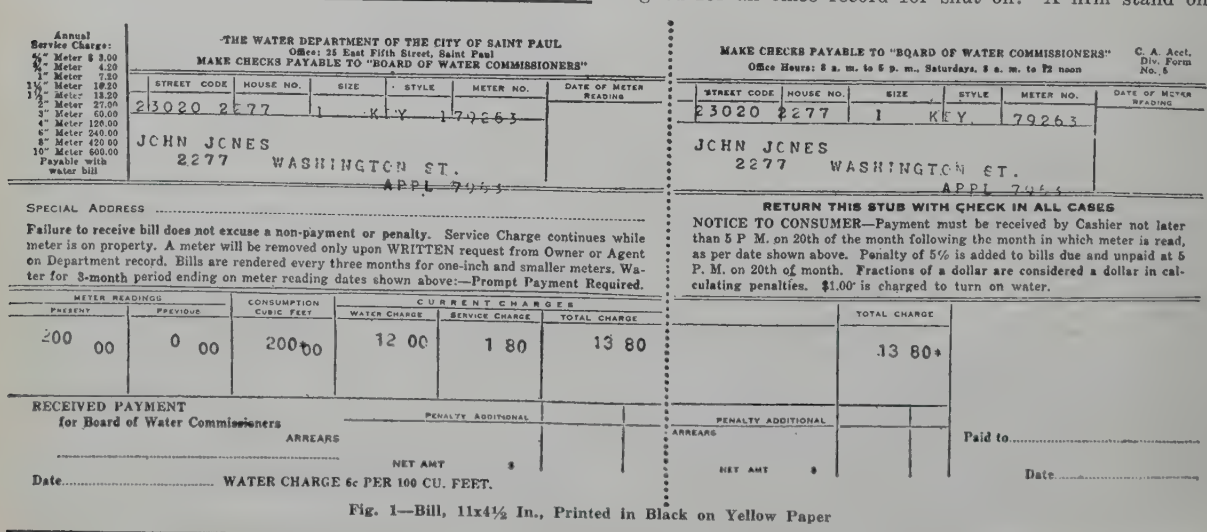
Accounting System for Large City

Methods of the St. Paul water department were described in *Water Works* by C. M. Crowley, registrar, water department, St. Paul, Minn., as follows:

Since Jan. 1, 1923, St. Paul's water department has been operated on the same plan as a private corporation managing a railroad or other utility, and its accounting system closely follows their best practice. Stores account, cost accounting, etc., and monthly and annual reports are issued and open to the public. The state public examiner audits the department in the same way as a county auditor or county treasurer's office, and requires up-to-date, safe and sound procedure in every division.

A brief account of the practice and methods in the revenue division may be of interest to some of your readers:

Accounting Methods.—Ninety-eight per cent of the active accounts are metered. All new supplies must be metered except automatic fire supplies. Meters 1 in. or less are designated as "domestic," 1¼ in. and over as "commercial." Domestic meters are read quarterly by dividing the city into three reading districts, reading and billing one district each month. Commercial meters are read and billed monthly. The meter rate is 6 ct. per 100 cu. ft. for all consumers. A monthly "service charge" is added to each bill according to the size of the meter while it remains on the property. Meters are removed only on request in writing by the owner or agent, and access given to property for removal. This avoids all dispute between the owner and the department, as 95 per cent of the requests are signed for an office record for shut off. A firm stand on



Annual Service Charge:
¾" Meter $ 3.00
¾" Meter 4.20
1" Meter 7.30
1¼" Meter 10.20
1½" Meter 13.20
2" Meter 27.00
3" Meter 60.00
4" Meter 120.00
6" Meter 240.00
8" Meter 420.00
10" Meter 600.00
Payable with water bill

THE WATER DEPARTMENT OF THE CITY OF SAINT PAUL
Office: 25 East Fifth Street, Saint Paul
MAKE CHECKS PAYABLE TO "BOARD OF WATER COMMISSIONERS"

STREET CODE	HOUSE NO.	SIZE	STYLE	METER NO.	DATE OF METER READING
23020	2277	1	KEY	179263	

JOHN JONES
2277 WASHINGTON ST.
APPL 7465

SPECIAL ADDRESS .....

Failure to receive bill does not excuse a non-payment or penalty. Service Charge continues while meter is on property. A meter will be removed only upon WRITTEN request from Owner or Agent on Department record. Bills are rendered every three months for one-inch and smaller meters. Water for 3-month period ending on meter reading dates shown above:—**Prompt Payment Required.**

METER READINGS PRESENT	METER READINGS PREVIOUS	CONSUMPTION CUBIC FEET	CURRENT CHARGES WATER CHARGE	CURRENT CHARGES SERVICE CHARGE	CURRENT CHARGES TOTAL CHARGE
200 00	0 00	200 00	12 00	1 80	13 80

RECEIVED PAYMENT
for Board of Water Commissioners

PENALTY ADDITIONAL
ARREARS
NET AMT $

Date..... WATER CHARGE 6c PER 100 CU. FEET.

MAKE CHECKS PAYABLE TO "BOARD OF WATER COMMISSIONERS"
Office Hours: 8 a. m. to 5 p. m., Saturdays, 8 a. m. to 12 noon
C. A. Acct, Div. Form No. 5

STREET CODE	HOUSE NO.	SIZE	STYLE	METER NO.	DATE OF METER READING
23020	2277	1	KEY	79263	

JOHN JONES
2277 WASHINGTON ST.
APPL 7465

RETURN THIS STUB WITH CHECK IN ALL CASES

NOTICE TO CONSUMER—Payment must be received by Cashier not later than 5 P. M. on 20th of the month following the month in which meter is read, as per date shown above. Penalty of 5% is added to bills due and unpaid at 5 P. M. on 20th of month. Fractions of a dollar are considered a dollar in calculating penalties. $1.00 is charged to turn on water.

TOTAL CHARGE
13 80

PENALTY ADDITIONAL
ARREARS
NET AMT $

Paid to.....
Date.....

Fig. 1—Bill, 11x4½ In., Printed in Black on Yellow Paper

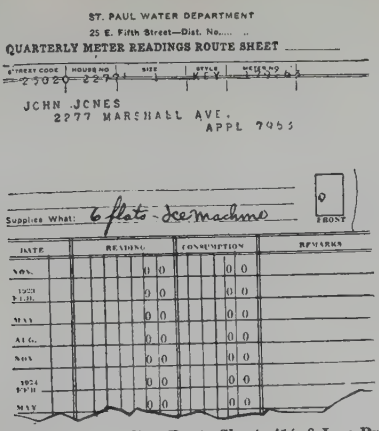


Fig. 2—Quarterly Meter Reading Route Sheet, 4½x8 In.; Printed in Black on White Paper; Ruled in Red and Blue and Perforated for Filing

this is very important in order to avoid disputes and consequent friction with the public. Experience has convinced the department that postponed disputes are the most aggravating. To settle it on the spot is the safest practice if at all possible. The water charge and service charge are itemized separately and consumers show closer attention to use and waste than they would under a minimum rate, which offers no reward for using less than the minimum charge. The minimum rate idea on metered water is therefore to a degree contradictory and naturally has tendency to increase per capita consumption by small consumers, while the meter is installed to reduce it. The service charge seems to be the soundest practice.

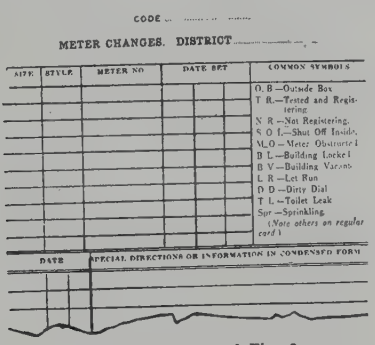


Fig. 3—Reverse of Fig. 2

Penalties.—Meter bills (Fig. 1) are penalized 5 per cent on each dollar or fraction of a dollar, if not paid on or before the 20th day of the month following meter reading, as shown on bill. As each day's exact receipts are deposited with the city treasurer the following morning, bills not reaching the cashier at closing time are returned without exception, unless penalty is included.

Meter Reading.—Meter reading sheets (Fig. 2) run from 2 to 6 years and carry a notation indicating what each supplies (with corresponding notation on ledger). The reader checks consumption with previous reading, and if high reading is sustained inspects for leak or cause of excess and notes same on reading sheet. He also leaves written notice to repair on property, with carbon copy returned to office. The consumer being caught red-handed, has no excuse and comes into the office with notice of repair and an apology instead of a kick, thus sparing the "kick clerk" and official staff much loss of time and criticism and friction. When the consumer is convinced that all are treated alike, he grins and bears it.

The department furnishes the meter and stands wear and tear, but hot water and frost damage is paid for by property. The reverse side of the reading sheets show meter changes and space for special notation. (Fig. 3.)

We trial balance about 60,000 accounts of all kinds in from 2½ to 3 days. We are prepared for audit on a moment's notice, or without it.

Meter Ledgers.—The meter ledgers (Fig. 4) show serial number of street service, reading district, size, style and number of meter, size of street service, owner of property and official street number, special address, monthly service charge and character of supply.

The ledger clerk compares the consumption with previous charges and above records and makes charge on an Underwood bookkeeping machine with a proof record, laying aside bills requiring further information, or noting prorate charges as the case requires. The corresponding bills are turned over to bill clerk with reading book. The bill clerk carries a schedule on his machine showing as follows: "Present Reading," "Old Reading," "Consumption," "Water Charge," "Service Charge," "Total." His schedule is then compared with the ledger clerk's tally roll and if they agree the books are in balance, the significance of which will be readily appreciated by department officers in charge of accounting involving a trial balance. Accuracy of subtractions and additions is attested by a star in all cases. Completed schedules, therefore, show total consumption, total water charge, total service charge, total of all charges, for each ledger. The control clerk takes these schedules, which show name of clerk and ledger number, and charges each ledger with total amount of days charges, with a similar practice for the day's receipts. The trial balance taken by the ledger clerks must agree with the control.

One entry clerk enters all cash payments in skeleton except where checks are received. In case of N. S. F. check or involved payment we find this practice a sound one for public accounting, as it places a check on cash beyond dispute. Cash coupons are again separated by ledgers and scheduled and posted by machine proving totals. Stubs are kept two years on advice of city comptroller and public examiner for audit purposes—if necessary.

Changing readers on routes and a separate reader on disputed bills does away with all chance of curb reading, as we keep an efficiency record with each. For 1924 a total of 36 errors is quite a satisfactory record in view of the fact that quite a district of the city is subject to spring overflows, clouding meter dials, etc., and with only 110 service pipes to the mile of main.

A straight 6 ct. rate enables us to prove the charge by the consumption. A step rate would not be so satisfactory in that regard. Our dual system may seem overelaborate,

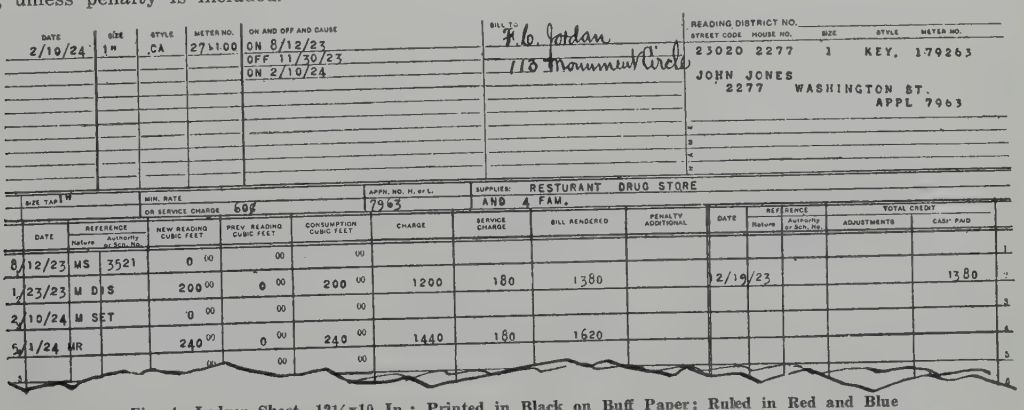


Fig. 4—Ledger Sheet, 12½x10 In.; Printed in Black on Buff Paper; Ruled in Red and Blue

but in public accounting, with every consumer a critic and having a right to examine the record, peace of mind and the satisfaction of leaving a clear record justifies the little extra effort required. Even at the peak hour of the last day for avoiding penalty our small office lobby rarely shows 30 people. Machine accounting has been a great assistance in improving a good system previously in practice. Limited vault space and fire risk induced the department to install a very satisfactory all-steel roll-top desk, with lock, for ledger cards. A code system is used to designate ledger accounts by numbering the alphabet, with street in the order of their installation in ledger, the house number constituting the ledger page, thus:

23020-2277 (Washington Ave. W.)
John Jones.

The bookkeeping machines used in this accounting system were furnished by the Underwood Typewriter Co. and the listing machines by Burroughs Adding Machine Co.

Use of Machines in Water Works Accounting

The following description of the use of machines in water works accounting was given by G. P. Moore, Jackson, Miss., in Water Works.

Four general plans for handling consumers' accounting work are:

Stub Plan
Register Sheet Plan
Ledger and Bill Plan
Dual Plan

The Stub Plan.—The stub plan, inasmuch as it seems to be the most popular of the present systems, will be discussed first.

We find some stub plans show more information on the ledger stub than others. One form may show only the current and past due charges. Another may show the consumption and amount due. Still others contain a record of meter reading, consumption and amount due. In this latter instance the additional stub or ledger record becomes an individual monthly ledger showing all the information formerly appearing in the old fashioned bound ledgers.

Credit posting methods for stub plans varies with the different users, although it is the general practice to perform this operation by the process of matching the paid cashier's or auditor's coupon with the ledger stub, separating the paid ledger stubs from the unpaids.

Some users then permanently bind the ledger stubs together. Others simply file the paid stubs separately from the unpaids. Either the right or left corner may be cut off or the ledger stub stamped paid as evidence of payment.

This credit posting operation may be performed every day or the paid cashier's stubs allowed to accumulate until after the expiration of the due, penalty or discount date, when they are then posted as one operation.

The Register Sheet Plan.—The register sheet plan gets its name from the use of the register sheet, made by the machine at the time the bill is prepared, as the consumer's ledger record. This plan has been popular in certain European countries for years.

There may be from 25 to 40 different consumers' records for the current month on each individual register sheet. Opposite the copy of the bill rendered is placed either the name and address on the account number of that particular customer. Arrears, additional charges or adjustments are also posted to this sheet next to the current amount column.

Credit posting is by machine, rubber dater stamp method or pen and ink.

Cash may be posted either daily or immediately after due, penalty or discount date.

The Ledger and Bill Plan.—The ledger and bill plan provides an individual continuous consumer's ledger card or sheet, which is debit posted at the time the bill is prepared.

The dual plan gets its name from the method of preparing the bill as a separate operation from debit posting the ledger.

Application of Machines.—In considering the application of machines to consumers' accounting problems, it should be thoroughly understood that no matter what type of plan is decided upon the machine operations can be simplified and speeded up by making use of the following desirable features now available.

(a) Automatic cross tabulating carriage.

This device automatically tabulates the carriage after each operation of the machine and returns the carriage to first position after the posting in the last position has been made.

(b) Automatic repeat print.

This device automatically repeat prints the items, entered on the bill, as original entries on both ledger and cashier's stub, thereby eliminating the use of carbon records.

(c) Automatic line finder.

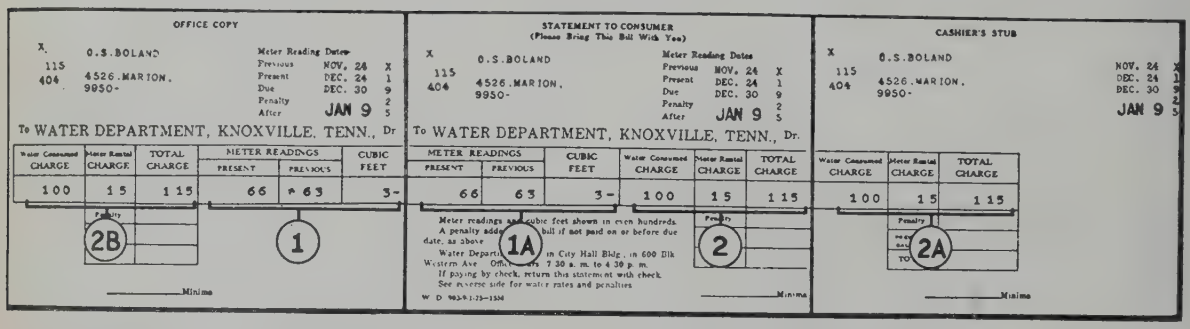
This device causes the bill and ledger to fall into pre-determined writing position without any effort on the part of the operator.

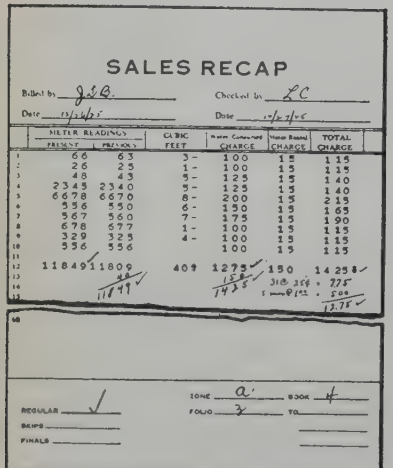
(d) Automatic opening of throat.

This device automatically causes the carriage platen to release the bill and ledger at the completion of each bill for easy removal and the insertion of the next consumer's record.

(e) Writing of bill, cashier's stub, ledger and sales recap sheet at one operation.

(f) Automatic accumulation of de-





How Burroughs Public Utility Machine Is Used by Knoxville, Tenn., for Writing Water Bill, Ledger Stub and Sales Recap in One Operation

Chutes for bill with adjustable tables for locating the printing line, are provided on machine carriage permitting easy insertion of bill to the desired position

(1) The operator sets up in the key board the present and previous readings and the consumption printing on the ledger stub of the bill, the carriage automatically moving forward to (1a)

(1A) An automatic repeat print of (1) on bill copying through to recap, the carriage automatically moving forward to (2)

(2) The water charge, meter rental and total charges are now placed in the key board printing on the bill and copied through to the recap, the carriage automatically moving forward to (2a)

(2A) An automatic repeat print of (2) on the cashier's stub

(2B) An automatic repeat print of (2) on the ledger stub, the carriage automatically tabulating to position (1) ready for posting of next bill.

The machine automatically accumulates the six desired totals on the recap

sired totals for easy proof of billing and debit posting as well as for revenue purposes.

How the Machine Works.—The application of the machine embodying all of these desirable characteristics, together with its operation, will be briefly outlined:

It is a well known fact that water meters may get out of adjustment, due to dirt, chemicals in the water, freezing, etc. This makes it necessary to keep a careful check on the condition of the water meter as reflected by the meter readings.

The meter reader's book should be turned over to the checker, as soon as readings have been made, so that the consumption can be entered on the meter read sheet and checked for the condition of the meter.

Assuming that we are in the billing department of a water works, we will just visualize the machine operation:

The operator seated before the machine has her work arranged in the following manner: To the left on the check table is located the meter read sheet. Just in back of the meter read sheet is the billing chart. To the right of the operator is a bill holder from which the magazine in the bill chute is replenished.

The sales recap sheet with carbon over it is placed around the carriage platen to record from 50 to 100 bills.

The bill is dropped into the bill chute, falling into writing position without adjustment by operator.

The carriage release bail is touched, bringing the bill and sales recap sheet into printing position.

The operator then obtains from the meter read sheet the present and previous readings, together with the consumption and prints these three sets of figures by depressing the proper keys and the motor bar.

The machine prints this information on the ledger stub, automatically tabulating and repeat printing the same three sets of figures on the bill, carbon copying on the sales recap sheet, accumulating three separate sets of totals in the lower adding machine and again automatically tabulating to the next position on the bill.

While the machine is performing these mechanical operations the operator is obtaining from the billing chart the consumed charge, the meter rental charge and the total charge to be billed.

As soon as the machine stops in position two (2), the operator is ready to enter these three sets of figures by depressing the proper keys and motor bar.

The machine prints these three sets of figures on the bill, cashier's stub, ledger and sales recap sheet, accumulating three separate sets of totals in the upper counter of the machine, automatically repeat printing, tabulating, returning to position one, releasing the completed bill ready for easy removal.

Thus it is readily seen that with two simple keyboard setups the operator writes a complete line across the bill, cashier's stub, ledger and sales recap sheet at one operation.

The six sets of totals automatically accumulated by the machine are cleared out on the bottom of the sales recap sheet at the completion of the unit run of from fifty to one hundred bills.

Proof of the accuracy of the bills is obtained as follows:

The totals of the consumption and previous reading columns must agree with the total shown under the present reading column.

The consumption for other than minimum bills is multiplied by the rate. This total plus the minimum bills must equal the total shown under the water consumed charge column.

The totals of the water consumed charge and the meter rental charge must equal to the total shown under the total charge column.

Contents of Tanks and Cisterns Per Foot of Depth

From U. S. Cast Iron Pipe & Foundry Co.

Diam. Ft. In.	Area Sq. Ft.	Gals. 1 Foot Depth	Diam. Ft. In.	Area Sq. Ft.	Gals. 1 Foot Depth	Diam. Ft. In.	Area Sq. Ft.	Gals. 1 Foot Depth
4— 0	12.57	94.00	10—3	82.52	617.26	20—3	322.06	2409.2
4— 1	13.10	97.96	10—6	86.59	647.74	20—6	330.06	2469.1
4— 2	13.64	102.00	10—9	90.76	678.95	20—9	338.16	2529.6
4— 3	14.19	106.12	11—0	95.03	710.90	21—0	346.36	2591.0
4— 4	14.75	110.32	11—3	99.40	743.58	21—3	354.66	2653.0
4— 5	15.32	114.61	11—6	103.87	776.99	21—6	363.05	2715.8
4— 6	15.90	118.97	11—9	108.43	811.14	21—9	371.54	2779.3
4— 7	16.50	123.42	12—0	113.10	846.03	22—0	380.13	2843.6
4— 8	17.10	127.95	12—3	117.86	881.65	22—3	388.82	2908.6
4— 9	17.72	132.56	12—6	122.72	918.00	22—6	397.61	2974.3
4—10	18.35	137.25	12—9	127.68	955.09	22—9	406.49	3040.8
4—11	18.99	142.02	13—0	132.73	992.91	23—0	415.48	3108.0
5— 0	19.63	146.88	13—3	137.89	1031.5	23—3	424.56	3175.9
5— 1	20.29	151.82	13—6	143.14	1070.8	23—6	433.74	3244.6
5— 2	20.97	156.83	13—9	148.49	1110.8	23—9	443.01	3314.0
5— 3	21.65	161.93	14—0	153.94	1151.5	24—0	452.39	3384.1
5— 4	22.34	167.12	14—3	159.48	1193.0	24—3	461.86	3455.0
5— 5	23.04	172.38	14—6	165.13	1235.3	24—6	471.44	3526.6
5— 6	23.76	177.72	14—9	170.87	1278.2	24—9	481.11	3598.9
5— 7	24.48	183.15	15—0	176.71	1321.9	25—0	490.87	3672.0
5— 8	25.22	188.66	15—3	182.65	1366.4	25—3	500.74	3745.8
5— 9	25.97	194.25	15—6	188.69	1411.5	25—6	510.71	3820.3
5—10	26.73	199.92	15—9	194.83	1457.4	25—9	520.77	3895.6
5—11	27.49	205.67	16—0	201.06	1504.1	26—0	530.93	3971.6
6— 0	28.27	211.51	16—3	207.39	1551.4	26—3	541.19	4048.4
6— 3	30.68	229.50	16—6	213.82	1599.5	26—6	551.55	4125.9
6— 6	33.18	248.23	16—9	220.35	1648.4	26—9	562.00	4204.1
6— 9	35.78	267.69	17—0	226.98	1697.9	27—0	572.56	4283.0
7— 0	38.48	287.88	17—3	233.71	1748.2	27—3	583.21	4362.7
7— 3	41.28	308.81	17—6	240.53	1799.3	27—6	593.96	4443.1
7— 6	44.18	330.48	17—9	247.45	1851.1	27—9	604.81	4524.3
7— 9	47.17	352.88	18—0	254.47	1903.6	28—0	615.75	4606.2
8— 0	50.27	376.01	18—3	261.59	1956.8	28—3	626.80	4688.8
8— 3	53.46	399.88	18—6	268.80	2010.8	28—6	637.94	4772.1
8— 6	56.75	424.48	18—9	276.12	2065.5	28—9	649.18	4856.2
8— 9	60.13	449.82	19—0	283.53	2120.9	29—0	660.52	4941.0
9— 0	63.62	475.89	19—3	291.04	2177.1	29—3	671.96	5026.6
9— 3	67.20	502.70	19—6	298.65	2234.0	29—6	683.49	5112.9
9— 6	70.88	530.24	19—9	306.35	2291.7	29—9	695.13	5199.9
9— 9	74.66	558.51	20—0	314.16	2350.1	30—0	706.86	5287.7
10— 0	78.54	587.52	.....	.....	.....	.....	.....	.....

R. D. COLE MANUFACTURING CO.

ESTABLISHED 1854

Newnan, Ga.

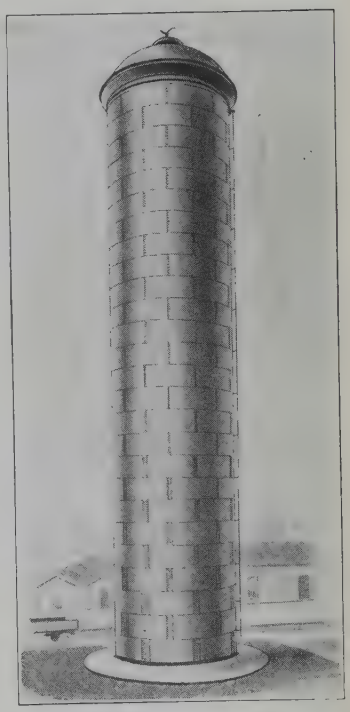
Tanks, Boilers and Steel Plate Work

BRANCH OFFICE: 5 BEEKMAN ST., NEW YORK CITY

Products: Steel Tanks, Stand Pipes, Elevated Tanks, Steel Stacks, Gas Tanks, Gas Holders.

Horizontal Return Tubular Boilers: Constructed in a most approved manner and of materials in full accordance with the A. S. M. E. Code.

Standard settings can be provided with stationary or shaking grates, and where increased efficiency and compactness are desired standard steel casings can be provided for these settings.



Steel Tanks, Towers and Standpipes: This company designs, fabricates and erects steel tanks and towers for sprinkler or general service, also standpipes.

Cole elevated tanks are correct in design. Their simplicity contributes to their low cost of maintenance. Sprinkler tanks and equipment are designed to incorporate the recommendations of all insurance authorities.

This company has been building tanks, towers and standpipes for over thirty years and its exceptional facilities, together with its large force of tank experts, insure reliable work and prompt delivery.

Steel Plate Construction: The facilities of the R. D. Cole Manufacturing Company provides for the design and construction of all forms of steel plate work, including smokestacks, acid and pressure tanks, structural frames and towers, etc.

A large and experienced engineering department is at the service of prospective customers to assist on solving their problems.

Water Waste Surveys

The methods used at Ottawa, Ont., for locating leakage were described as follows by A. D. Stalker, Engineer, Waste Detcetion Branch, Works Department, Ottawa, Ont., in *Water Works*:

Waste control, as a subject, can be divided very conveniently into two parts: First, that having to do with wastage which takes place inside houses and other buildings; and second, that concerned with wastage from the underground portion of the distribution system.

Causes of Waste.—The wastage which takes place inside buildings is caused largely by defective plumbing fixtures, and by carelessness. In cities and towns that have very warm weather in summer and very cold weather in winter, a great deal of water is wasted in lawn sprinkling in the first instance, and to prevent freezing in the second. I use the word "wasted" advisedly.

It is perfectly true that well-kept lawns add to the attractiveness of a city to an extent that makes them well worth the cost of the water necessary to keep them in good condition. Water used intelligently for this purpose cannot properly be considered waste. The trouble lies in the fact that unfortunately water is not always intelligently used for this purpose.

There is certainly no necessity for having lawn sprinklers running during a storm, yet this is something that quite frequently happens. The amount of water used for lawn sprinkling can be materially reduced by having a by-law stating certain off-peak hours during which sprinkling is allowed, and providing penalties for sprinkling at any other time. The effectiveness of such a by-law will depend almost entirely on the extent to which it is enforced.

The running of water to prevent freezing should be prohibited. Plumbing by-laws should be so framed as to insist on the pipes leading from the main to the house being laid below the frost line, and on the piping inside the building being kept away from exterior walls, and installed in such a manner as to remove the danger of freezing.

Meterage As a Remedy.—By far the most effective method of dealing with the wastage that takes place inside buildings is by having services 100 per cent metered. The person who has to pay for water through a meter can generally be depended upon to be economical in its use. To make the watertaker pay for the water he wastes, will reduce that waste to a minimum.

In cities or towns where none, or only a small percentage of the services are metered, the control of waste from defective plumbing fixtures is much more difficult. Systematic house-to-house inspection, regularly maintained by a permanent staff of inspectors, will prove a great aid in keeping this class of waste within reasonable bounds. These inspections must be frequently repeated, and to be effective must be supported by strong laws and good plumbing ordinances.

In Ottawa when defects in plumbing fixtures are located by any one of the inspectors, the owner of the property is given 48 hours in which to make the necessary repairs. The inspector re-examines the premises at the expiration of the 48 hours, and if repairs have not been made, the service is shut off, and before it is again turned on repairs must be effected, and the owner is compelled to pay the sum of $1.00 as a charge for the services of the turnkey.

The water that is wasted as the result of pure carelessness is probably as difficult a class of waste to deal with as any. Educational campaigns and public appeals, while no doubt effective in the face of actual or impending water famine, do not seem to be impressibly effective where no such famine, or threat of famine, exists.

So long as the source from which the water is drawn is ample for the community's needs, the public seems to labor under the delusion that in some mysterious way the whole supply is available for use without the expenditure of either money or labor.

Our public also seems to think that the information contained in educational literature dealing with the importance of attending to small leaks and wastes should make a great impression—on somebody else. The value of this type of waste-control work is debatable. The writer's opinion is that the results obtained are not worth the trouble and expense of getting up and distributing the literature. The only cure for waste due to carelessness is metering.

The Pitometer.—The second phase of waste reduction has to do with the location of leakage from the underground portion of the distribution system. To find the leaky parts of the underground system, a survey must be made to ascertain where the water goes after leaving the pumps, and what parts of the system receive excessive quantities. This can be accomplished by means of a pitometer.

The pitometer is an instrument that adapts the "Pitot" principle to the measurement of water. Two tubes enclosed within a metallic sheath are introduced into a water main through a 1-in. corporation cock. The tubes are set in such a position that one orifice faces directly up-stream and the other directly down-stream. They are connected by means of rubber tubing to a glass U-tube containing a liquid of a specific gravity higher than water and which will not mix with it. The difference between the pressure on the downstream and on the upstream orifices, which is the pressure due to velocity, causes a deflection of the liquid in the arms of the U-tube, and from this deflection the flow is calculated.

The prism photo recording pitometer makes a continuous photograph of the U-tube fluctuations upon a sheet of sensitized paper attached to a drum revolved by clock-work. The drum can be geared to complete a revolution in 12, 24 or 48 hours. From this photo record the flow through the main can be ascertained for any time during the gauging.

To measure accurately the flow through mains with the pitometer, the ratio of the mean velocity to the center volocity must be established, as the orifices of the instrument are set at the center. This ratio is called the "pipe co-efficient" and is established by traversing the pipe. A pipe traverse is made by taking readings of the velocity at intervals across the pipe sufficiently close together to make a smooth curve when plotted. The pipe section is divided into rings of approximately the same area. The mean velocity of each ring in feet per second multiplied by the area of the ring in square feet, gives the ring volume in cubic feet per second. The mean velocity for the whole pipe section is the total of these ring volumes divided by the area of the pipe. The mean velocity divided by the center velocity is the pipe co-efficient. On large mains it is desirable to traverse the pipe on two diameters 90 degrees apart and in the same plane. By using two rod meters, one can be left at the center of the pipe and the traversing done with the second, and readings taken when the center velocity is the same in each case. The pipe co-efficient is the same for all velocities in the same pipe at any particular point, and it is upon the discovery of this principle that all pitometer gaugings are based.

How Pitometer Survey Is Made.—A pitometer survey should properly start at the pumping stations, and the discharge from the pump checked. When this has been done, I think it good practice to test all trunk or feeder mains before dividing the system into districts. These mains taken separately can be quickly done, and the distribution of water through that part of the system fed by them is interfered with for a much shorter time than would be the case if they were to form part of a district. Furthermore, trunk mains are usually so spaced as to form excellent district boundaries.

More accurate results can be obtained if the pitometer tap is placed on a small main feeding into the trunk main than would be the case if the tap were to be placed on the trunk main itself, as a flow that would cause scarcely any deflection of the liquid in the U-tube if the tap were on the large main, would cause a sufficiently great deflection to give an accurate measurement of the flow if the tap were on the smaller main. The tap may be placed in such a position as to serve as a gauging point both for the trunk main and one of the districts.

The next step is the dividing of the system into districts. This work must receive careful consideration. A district should be of a size that can be conveniently sub-divided in one night during the hours of minimum consumption, and the boundaries laid out with a view to causing as little interference as possible with the circulation through the balance of the system. The gauging point should be on a main of such a size that a velocity of about 4 ft. per sec. would supply the maximum normal demands of the district, without any allowance for leakage. This velocity will give a deflection of about 17 in. on the U-tube, using a liquid of 1.25 specific gravity. The maximum consumption would not be likely to cause a velocity great enough to blow the liquid out of the tube, and the minimum consumption would

cause a fairly high deflection. When the district is first gauged, a velocity higher than the above will probably be recorded, and a heavier liquid might have to be used. The idea behind choosing a main of this size is to ensure a deflection high enough to give an accurate measurement of the flow when all leaks have been stopped.

It is necessary that those entrusted with waste reduction should become thoroughly acquainted with the conditions that exist in the various districts. The population and how it is distributed, and whether the area is industrial or residential, must be known in order to determine what quantity of water would be sufficient for its needs.

If the survey being made is an original one, a 48 hour record should be taken, including a Sunday if possible. Very careful records should be kept of all flows recorded and work done, and of any peculiar or unusual conditions that may be found to exist, as this information will, without doubt, be of great assistant in later surveys. Weather conditions and any circumstances which might affect the consumption of water should be noted.

When the flow is to be gauged, the district is cut off from the rest of the distribution system by closing all the valves on the boundaries, excepting on the pipe to which the instrument is connected. To make sure that the valves are holding properly, and that no water is getting in, either through them or through services that may be joined up inside buildings and connected to mains on both sides of a boundary, the main feeding the area enclosed should be closed and a hydrant at the highest point within the boundaries opened. If the hydrant is not off, the point at which the water gets into the district must be located, and the flow stopped. When it is assured that the whole supply passes through the main to which the instrument is connected, the district is ready for the taking of the record. Precautions should be taken to prevent street flushers drawing water from hydrants located within the district boundaries while the record is being taken. It is advisable also, to have a man with a valve key stationed at a fire hall either in or convenient to the enclosed area, so that valves could be opened with as little delay as possible in the event of a fire breaking out. If a fire occurs in a district while the flow is being recorded, the record will be ruined, and opening the boundary valves cannot make it any worse.

If the record taken indicates that an excessive amount of water passes the gauging point, and that the flow remains high during the hours in which very little water would be used, the district should be sub-divided. For subdivision purposes the mechanism revolving the drum of the pitometer is geared to complete a revolution of the drum in twelve hours. This will give a movement of an eighth of an inch in five minutes.

One method of sub-dividing is to divide the whole district into sections as small as the spacing of the valves will permit, and then closing a section down for a short period (at least five minutes) and re-opening it, and repeating this operation with other sections, until all have been shut down. Another method is to start at the boundaries and work towards the instrument, gradually reducing the size of the district, and as the new boundary valves are closed, the old ones are opened. The method used will depend on the conditions that exist in the district. With either method, the time each shutdown is completed must be noted. It is important that all valve operations should be checked over before leaving the district, to make sure that no valves are left closed.

Locating the Leaks.—When the subdivision record has been interpreted we will know the quantity of water each section of the district received. The sections that receive excessive quantities should be carefully gone over and the reason for the large flow ascertained. It is a good idea to have a plumbing inspector make a special examination of the fixtures in all buildings in these areas. If this inspection fails to account for the flow, it is assumed that the cause is underground leakage.

There are a number of methods usually employed to give the exact location of underground leakage. The one most generally used, and the one by which a great majority of leaks are found, is by sounding. There are a number of instruments on the market devised to help in picking up sounds, and those that I have used have proven of great assistance. The procedure is to sound all the valves, hydrants and services in the suspected area, and sometimes it is possible to get closer to the source by driving rods down to the main. It is remarkable what an experienced man can accomplish by sounding. In a great many cases he can not only tell where the leak is, but its nature—whether it is a blown joint, a split main, or a burst service pipe.

There are, however, a number of cases in which the sounds picked up are confusing. Where there are two or more leaks close enough together for the sounds to overlap, it is difficult to isolate the sound from one leak and trace it to its source. Leaks that discharge under water produce a sound that is often misleading. Then there is the abandoned service that has not been properly blanked at the main, but beaten up at building end. This practice was much more prevalent in the past than it is at present, but the leaks resulting have not yet been all located. In places that have had fires that burned over large areas, many such services exist. Leaks on these services are difficult to locate, for they generally occur on the beaten end, and as lead is a poor conductor of sound, if any noise at all is picked up, it is too faint to be of much help. If this method of blanking services still persists anywhere, those responsible for the management of the water department in that place are letting themselves in for a lot of future trouble.

Other methods used in conjunction with sounding include testing the pressure at different points until the point of minimum pressure is located; noting the flow in sewers at the manholes; pounding the road surfaces to endeavor to locate cavities beneath the pavement, and searching in cellars and excavations for dampness.

If the above expedients fail to locate the leak, the primitive of digging is resorted to. It is quite probable that the first hole put down will not be in the right place, but from the conditions that exist at this point, a second hole is usually all that is necessary.

Water appearing any place should be looked on as a possible leak, if the reason for its appearance is not apparent. The following is offered as an illustration: Some years ago, this city had a serious epidemic of typhoid fever. Water from any source other than the city mains was in great demand. During this time the writer noticed people drawing water from what appeared to be a spring located at the bottom of a hill. Those familiar with the locality insisted that this spring had always been there, and the city had had a sewer installed to carry off the overflow from it. A sample of the water was analyzed and the analysis showing that the water was very similar to that supplied by the city, the area in the vicinity of the spring was examined. At the top of the hill a 2-in. service that had been installed some thirty odd years previously, was found to be running full bore. This was stopped and the "spring" immediately dried up.

Other Duties of Waste Reduction Department.—In addition to the work outlined above, it is the duty of the department in charge of waste reduction to attend to all cases of flooding of cellars. The first thing to be done in these cases is to find whether or not the water department is responsible. In most cases a test of the electrical conductivity of a sample of the water is sufficient to decide. If the result of this test is not conclusive, an analysis of the water is made, and if it shows that the water comes from the mains, the leak is located by one of the methods mentioned above.

When serious breaks occur in the distribution system they usually give plenty of surface indication as to their locality. These are attended to by the trouble department. Bad breaks do accur without giving such indication, however, and these are followed up by the waste-reduction department. In such cases, the department first gets in touch with all the fire halls in the city, each of which has a pressure gauge installed, to find if possible an area in which the pressure has dropped. If no indication is given in this way, men are sent out to go over those parts of the system where it would be possible for the water from such a break to escape without surface indication. To know where to send the men requires an intimate knowledge of subsurface conditions throughout the city. Pipes crossing waterways and mains in rocky sections through which large sewer or other excavations have been cut, should be sounded, and if the leak still remains unlocated, short readings of the flow to districts is resorted to.

Results Obtained in Ottawa.—In 1918 the consumption of water was 218 gal. per capital per day. In 1926 it had been reduced to 150 gal. This consumption is still too high—much too high. Our past experience, however, leads us to expect that it will be materially reduced in the future.

What Water Waste Survey Disclosed

The following article by H. E. Beckwith, District Manager, The Pitometer Co., New York, N. Y., appeared in *Municipal News and Water Works:*

It is by way of returning in small measure the helpful courtesies shown us by the men in the water works field that this article is written, and with the hope that they may find some helpful hints in the conditions we have found in other plants.

When the Valves Were Closed.—It is, of course, very common to find closed valves. Attention is called to two such instances: In the first of these an entire town of some 20,000 persons was being fed through four 6-in. mains, because a valve on the main 16-in. feed was closed. Moreover, this was the only valve in the entire system found closed, showing that care was taken to check up on the valves. Furthermore, and this is of special importance, it was the only geared valve in the system. When the operating nut on the gear was turned in a clockwise direction, the valve stem was turned counter-clockwise. As the valve stem on this valve closed in the same direction as all other valve stems in the system, it was necessary to turn the operating nut in the direction opposite to that of every other operating nut in order to close the valve. Someone failed to take this into consideration, with the result that the valve had been kept habitually closed.

In the second case, the hydraulic grade line was apparently lower at one point than it was at another point on the same line, ¾-mile further from the source of supply. This was on the system of a small company serving several miles of territory with laterals feeding directly off one long main, or rather, it had been one long main originally. For 1½ miles of its length it had later been paralleled with another main. This second main was tied to the original main at no place other than at its ends, and no laterals came off of it. A study was being made for the purpose of reinforcing the system. When the hydraulic gradient for the system, as determined in the field, was plotted on cross-section paper, it was found that midway between the ends of the two parallel mains the hydraulic grade line was lower than at either end. Subsequently, the valve on the reservoir end of the "old" main was found to be closed. All water being used along the mile and a half of parallel mains had to go to the farther end and then feed back toward the reservoir. Opening the closed valve, of course, took the sag out of the grade line and increased pressure below the point where the valve had been closed. The trouble in this case was caused by right and left-hand valves being indiscriminately sprinkled throughout the system. Volumes could be written about the trouble caused by indiscriminate use of both right and left-hand valves in the same system. This is merely another example of the results of this practice.

Why the Supply Main Delivered No Water.—Speaking of hydraulic gradients, there is the case of the city whose officials had believed their system was being fed by two mains from the reservoir. A pitometer test proved, however, that there was no flow through one of these pipes. Further investigation showed that this main at one point actually lay above the water level of the reservoir. After the line was lowered, its vacation was over and it went to work delivering water to the city.

Accounting for a 50 Per Cent Loss.—Another very interesting case was that of a city which had originally been served by two separate companies. Later, these companies were merged and the distribution system was interconnected. Each of these companies originally secured its water by gravity from a mountain reservoir, the reservoir of one company being 12 ft. higher than that of the other company. Since the complete metering of this system a few years ago the meters through which water was sold had accounted for a little less than 50 per cent of the water shown on the Venturi meters installed at the reservoirs. Our tests showed that during the night, when the use of water in the system dropped low, the water fed out of the higher reservoir into the lower. It is the nature of a Venturi meter to measure in a positive direction the water which goes through it, regardless of the direction of flow. Consequently, the water which fed from the higher to the lower reservoir was measured on each of the two Venturi meters, although as a matter of fact, it was never used in the distribution system at all. When the Venturi meters were originally installed the city was on a flat rate basis, and the waste of water was so large that it is doubtful if the water ever backed up into the lower reservoir. But with the metering of all the services the amount of waste gradually fell off until the condition prevailed of which I have just spoken.

Whenever a water system is fed by gravity from two or more reservoirs on different levels, it is well to grow immediately suspicious of back-feeding when the supply in the lower reservoir holds up better than the supply in the upper one.

Incorrect Meter Reading.—Another very interesting case was that of a small suburban city which purchased water from its larger neighbor by meter. As the city was being paid on its meters for less than half the water entering the distribution system, the water department had accumulated a large deficit. In addition to the conditions usually found by a survey, it was discovered that two 4-in. and two 6-in. meters were being incorrectly read, and that the city was being paid for only 10 per cent of the water going through them. The value of the water which had passed through the meters, but which had never been paid for, was nearly equal to the deficit of the department. An effort was made to collect this money on the grounds that the bills rendered the consumer bore the meter readings and his acceptance and payment of the bills constituted an acceptance of the correctness of the meter readings. As the department did not use a step rate, the matter of billing was comparatively simple. It is to be regretted that we cannot advise you as to the outcome of this attempt to collect, as we left the city before any settlements were made. Two of the consumers had, however, expressed a willingness to pay; and I understand that the state commission had ruled that any failure on the part of the city to collect the full amount would be equivalent to the granting of preferential rates and would therefore be contrary to law.

This under-reading was caused by the fact that the smallest dial on the meters involved was graduated in units of one hundred, whereas the smallest dial on all other meters on the system was graduated in units of ten. The meter reader entirely overlooked the necessity of investigating the meter to determine in what units it was graduated.

How to Prevent Inaccurate Meter Reading.—That this is not the only case of its kind is shown by the fact that another similar condition was recently found. As a remedy for this it is suggested that meter readers be not permitted to take their previous readings on a meter into the field and so help to carry the error through. It is further suggested that the office clerks be forbidden to change any readings in order to make them conform to previous readings. Wherever a doubt exists as to the accuracy of the reading on a large meter, it would be well to have it checked by the meter company's representative.

In another suburban city, which also purchased its water through a meter, periodically the receipts from the water department would drop below the cost of its water. The trouble in this case lay in a compound meter to a steel mill. The high duty side of this meter was dead; and whenever business was sufficiently good with the steel company to cause a draught of water large enough to throw the flow onto the high duty side of the meter, business was very bad with the water department. Another factory in a different part of the city had been suspected of stealing the water, which is probably the one reason why the real cause of this lost water was not discovered before.

In the same place, the larger city had metered two services, and had for years been collecting revenue from them, when, in reality, the services were attached to the mains of the smaller town. Both cities had mains in this one street. In this case, all moneys that had been so collected were turned over to the smaller town.

The Source of the Spring.—In another suburban borough which purchased water by meter, the newspapers stated that the leak discovered by the survey had been running for

twenty-five years and had cost the borough in that time a quarter of a million dollars. This is not of particular interest here, except as it lends point to another statement made by the same news article. It seems that, when a large sewer was laid past this leak, it was impossible to handle the water with a pump. It was decided that a spring had been tapped and special foundations were put in to protect the sewer. It should be noted here that the leak was from the open end of an abandoned service, of which the borough had no record. In view of the known heavy losses, it is certain that the leak would have been discovered when this sewer was laid, had the water come from the direction of the main and not from the direction of a vacant lot.

It is remarkable how many springs, and swamps even, dry up after leaks on the water system are repaired. And how many people lose their source of valuable medicinal water.

Unauthorized Uses of Water.—Several years ago, when the stock of privately owner water companies was more or less a drug on the market, and few companies had paid dividends in many, many years, we caused considerable consternation on the part of the president of one company where we were working. It developed that a certain manufacturing company in the city was getting about 100,000 gal. of water a day free, through a defective meter. The president of the water company was also president of this factory. It was bad enough, he felt, not to get any dividends on his water company stock, without having the dividends of his factory cut into by increased water bills.

In another case we were called in to locate the cause of a large amount of water escaping from the high pressure system of a middle sized city. By a quirk of fate, it was discovered that 300,000 gal. per day of water were being surreptitiously taken from the system by a plant which was largely the property of the water commissioner. And he was the man who had been most instrumental in securing the commission for us in the first place. Certain it was that this water was being taken without this knowledge.

As a matter of fact, we find it generally true that where water is being taken in an unauthorized manner, it is done without the knowledge or consent of the higher officials of the companies. It is usually some department head wants to take a short cut to a good showing for his department.

Low Pump Discharges.—In recent years there has been a rapid increase in the development of electric power, with the result that many water plants have found it economical to substitute electrically driven centrifugal pumps for the old steam plant. Unfortunately, a full realization of the limitations of this type of pumping unit does not seem to have accompanied its installation. In only too many cases the only requirement placed on the pump is that it pump water. No apparent consideration is given to the efficiency with which this work is done. The displacement type of pump allowed so much latitude in operating conditions that many plant operators have not yet come to a full realization that centrifugal pumps operate efficiently only under the design head, and at the design rate of discharge.

No branch of work being done by our firm is more interesting than the efficiency tests on electrically driven centrifugal pumps. In one instance the pumping units were two 2,500,000-gal. pumps, working in parallel to give a combined output of 5,000,000 gal. per day. These pumps were designed to work against a head of 100 lb. The time came when these pumps would not carry the maximum day load. So the output was increased by putting the discharge of these two pumps through a 5,000,000-gal. pump designed to pump against a head of 50 lb. This gave then, an installation designed to pump 5,000,000 gal. against a head of 150 lb., whereas it was working against a head of only 100 lb. This gave an increased rate of discharge, but at a considerable cost in efficiency. This was not the sole reason why the wire to water efficiency of the installation was under 44 per cent, as several pieces of wood were later taken from the ports of one of the pumps, but it did have a very important bearing on the loss of efficiency. It is of interest to add that, after disconnecting the 50-lb. pump from the discharge of the two 500,000-gal. pumps, and cleaning these latter out thoroughly, a subsequent test on these two pumps gave an over-all wire to water efficiency in excess of 70 per cent.

In another instance the clear well was of such small size that it was necessary to coordinate the flow from the filters into the clear well with the pumpage out of it. As the low lift pump from the river to the filters had a higher rate of discharge than had the pump from the clear well to the distribution system, this coordination between the two pumps was secured by partially closing a valve on the discharge of the low lift pump. This increased the head at the pump above its design head and induced a slip into it. So much was this increase in head and slip that the power required to pump the reduced flow was much more than would have been required to pump the greater quantity for which it had been designed, had it been operating under design conditions. Throttled down, the pump had an over-all efficiency of approximately 30 per cent. A new low lift installation designed for a discharge equal to that of the high lift pump, thereby eliminating the necessity for throttling, gave on test, an over-all efficiency of approximately 60 per cent.

Another city had been computing its pumpage on a false pump rating, a rating in fact about double the pump's actual capacity. This pump rating was so much in error that, had it been correct, the installation would have had a wire to water efficiency in excess of 100 per cent. And the secret of perpetual motion would at last have been found.

These cases are called to your attention in order to emphasize the necessity for the services of a reputable engineer when this type of installation is contemplated. With the decreasing cost of electricity, this installation is becoming increasingly popular. The efficiency of electrical units should be closedly watched. The greater efficiency being obtained from modern units will often be sufficient to warrant the installation of new equipment.

The speaker recalls one instance where the replacement of an old installation having an over-all efficiency of 57 per cent with a modern unit having an over-all efficiency of 72 per cent decreased each monthly power bill an amount equal to 5 per cent of the total cost of the new installation.

Then there was the centrifugal pump whose 10-in. discharge line was reduced to 6 in. for a few lengths of pipe. The explanation given for this novel procedure was that the water pressure would be increased after going through the smaller pipe. This reasoning sounds strange to us today, but one of our engineers, delving through the council records of a city where he was working, found a case equally interesting.

When Hydraulic Knowledge Was Limited.—Some sixty years ago when our knowledge of hydraulics was not as extensive as it is today, an engineer had been employed to design a main between the reservoir and the city. This main was partly 20 in. and partly 18 in., fed by a 12 in. from the reservoir. The engineer in charge of the work was the author of the following interesting explanation:

This main line of pipe was enlarged by the direction of the Committee on Water under the light head at the Westerly end, to render the same much more effective as a means of conveying and delivering water at the extreme end of the pipe here in the city. Since the lighter the head, the larger is the required diameter of the pipes necessary to furnish the amount of water conveyed by the small pipe under a much greater increase of head; this change has been one of much utility in increasing the efficiency of this supply main.

Within ten years after the main was put in service, the supply in the city became so deficient that the main was not full at all times. The report of the Water Committee says:

While the discussion was going on about the high service, the engineer discovered that the main pipe already laid was wrong end first, and that the advantages of having a small pipe near the reservoir to fill and supply a larger one in the city, were not so great as he at first supposed.

Locating Leakage

There are numerous appliances available for locating leakage, such as the aquaphone, Darley leak locater, detectophone, geophone, sonofone, sonograph and sonoscope. All these work on the principle of the audibility of water flowing through a leak. The Clark leak indicator operates through loss of pressure and is used for services. Water pressure diagrams also are useful in locating leakage. Pipes may be located by the detector, wireless pipe locator and similar devices.

Locating Leaks with an Aquaphone

The following useful suggestions on locating leaks with the aquaphone was given by E. O. Sweet, Chief Engineer, Birmingham Water Works Co., Birmingham, Ala., in *Municipal News and Water Works.*

If you send a man out to locate leaks with an aquaphone, make him take along a hydrant wrench and a curb stop key. Insist that if he hears a leak on a service that he close the curb stop and listen again. If he does not hear it then, the leak is beyond the meter, and he should stop long enough to ascertain if the meter is catching the leak. If he hears a leak on several services in the block, make him stop long enough to find on which service it sounds loudest. This is the point nearest the leak and it will save time for the repair men to have this knowledge. Another inexpensive and quick way of finding leaks in our larger cities is to send men through the large trunk storm sewers. Many leaks have we found by so doing. Another quick method is to look into all telephone company duct manholes. Water will often be found entering their ducts and flowing to a manhole.

Locating Pipes and Leaks with Electric Pipe Locator

Carl A. Hechmer, Department Engineer, Washington Suburban Sanitary District, Hyattsville, Md., gives the following in *Water Works:*

Locating Pipes.—There are several instruments on the market which aid maintenance work on distribution systems. The electric pipe locator is one of them and if used carefully is a very valuable instrument. We have found it capable of doing all the things claimed for it by the manufacturers and we have saved its cost many times in locating old pipes. We recently took over the control of a small water system containing several miles of pipe lines and about 50 service connections. No drawings or records were available and we used the pipe locator to map the system. Pits dug on the main lines to install control valves and on all service pipes to install meter housings revealed, without exception, that the locator had indicated the correct location. After a little practice with the locator anyone can use it and depend on the results.

Locating Leaks.—We have also saved hundreds of dollars using the electric leak locator in finding leaks on pipe lines, especially under improved streets. The first time we used the instrument we located a bad leak under a concrete street, the instrument having indicated the leak within 18 in. of the broken pipe, although water was coming out from both sides of the pavement for a distance of 25 ft. and the largest volume of water was coming out at about 20 ft. from the point at which the pipe was actually leaking.

The aquaphone is another instrument which we have found very useful. It sells for only a few dollars and resembles a telephone receiver. It is used to test house plumbing for leaks and to detect valves on distribution systems which fail to shut off the water tightly.

A dip neddle is almost an indispensable instrument for locating valve and curb cock boxes which have become covered with earth or paving material. It depends on the principle of magnetism, the iron box attracting the magnetized needle, causing it to dip when it is passed over the box.

Locating Leaks with Pitometer and Geophone

A combination of the pitometer and geophone in the hands of an experienced man can produce excellent results in locating leaks. In April, 1924, *Water Works,* Messrs. J. N. Chester and E. E. Bankson described how this combination was used at Piedmont, Va., and Patton, Pa.

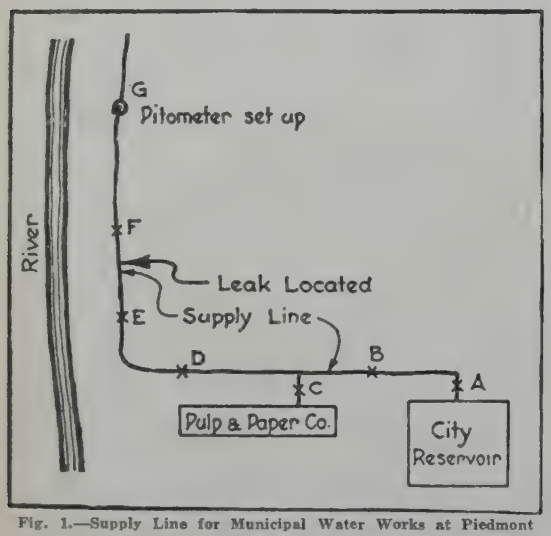


Fig. 1.—Supply Line for Municipal Water Works at Piedmont

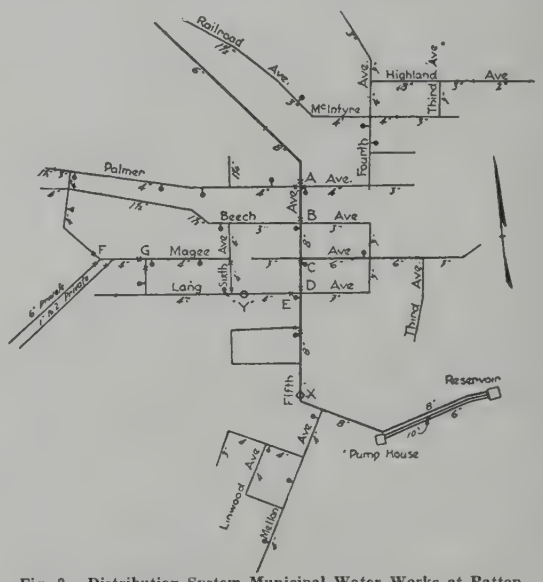


Fig. 2.—Distribution System Municipal Water Works at Patton

Principle of Simple Case.—The experience at Piedmont may be used to illustrate the principle of the most simple case, which may be described by use of Fig. 1, where the supply line is shown coming from the gravity source of the city reservoir, with very few services on the supply line previous to its entrance to the reservoir; the service of the pulp and paper company being the only one here shown.

For some years the paper company has been looked upon as the culprit who was stealing water from the city's supply lines. The suggestion that "the pitometer would produce the evidence brought forth the response that they were positive there were no leaks in the line because they had carefully watched that feature and, from experience, they had found that the leaks always readily came to the surface, anyway. The approximate location of valves are shown at A, B, C, D, E and F, and the pitometer set-up shown at

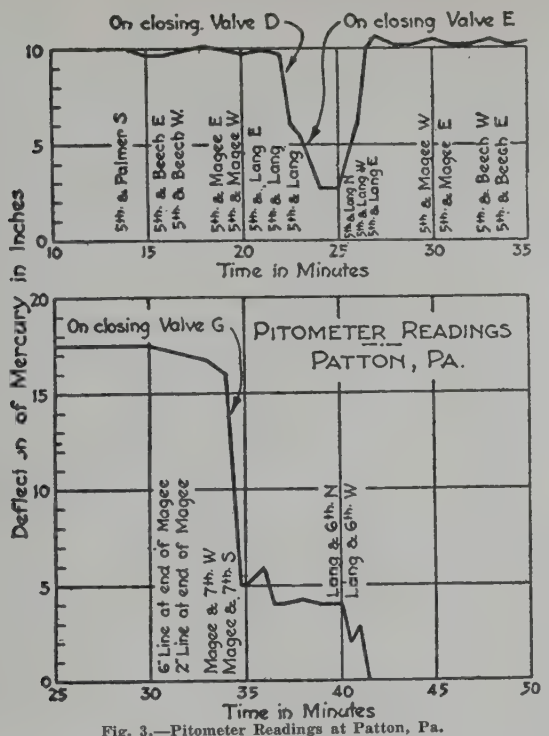


Fig. 3.—Pitometer Readings at Patton, Pa.

G, where it was determined that practically the full supply was passing.

After the pitometer was in place and ready for operation, the valves were closed in succession from A to F at time of low flow in the night. No reduction in the flow passing the pitometer at G was noted until after valve F had been closed, which means that the leakage was between E and F, and by the process of a few setups, with the pitometer run from F towards E, together with the use of a geophone, we finally located the leak which was creating all the trouble and which was running into the river below the ordinary flow line in such a way that it had never been detected all these years.

How Leakage Is Determined for a Distribution System.—The experience at Patton may be used to demonstrate the more complicated case, and this would apply to any size of system by the process of breaking that system up into parts. The distribution system for Patton is shown on Fig. 2.

Valves had been closed in certain parts of the system in such a way that valves A, B, C, D, E, F and G would serve as controlling points and with the pitometer at X, valves A, B, C and D were closed at the time of low flow in the night and no reduction of flow passing the pitometer was indicated until the valve D was closed, which meant that the leak was between C and D and was later definitely located by means of a geophone and again when valve E was closed a second reduction was noted. The pitometer was then set up at Y and the three valves at F were closed with no reduction in flow, but on closing G a decided decrease was observed, indicating that the leak was between F and G, which was also located by the geophone, in each case the leak flowing away underground unobserved. Pitometer readings for the case are shown on Fig. 3.

The process as described for Patton required only a few minutes for each operation of closing a series of valves and then opening them in the reverse order as a means of using the increases in flow as a check on the original decreases in flow during the operation of closing the valves.

Several examples like this could be cited where only two or three nights have been consumed in finding the serious leaks and the superintendents of some of these plants now swear by the geophone and refuse to be without one, such as at Etna, Edgeworth and West Newton, Pa. The survey at Etna, Pa., of about three nights' work, discovered two or three major leaks which reduced the electric pumping bill from about $500 or $350 per month.

Cleaning Cast Iron Water Mains

An interesting account of the experiences and results obtained in cleaning cast iron pipe lines was given by Charles Haydock, engineer, water companies, Philadelphia, Pa., in *Water Works*.

If the capacity of a long line appears to be decreasing or the pumping head increasing, the actual carrying capacity should be determined. If this is materially less than the theoretical capacity, a careful investigation should be made to determine the cause. A survey and determination of the hydraulic grade line is usually worth the cost, and will disclose any unusual conditions. If it is possible to shut down the line, static pressure or a siphon test will show how tight it is and a recording meter will complete the record. If there is no meter available, a pitot test can be made at a reasonable cost. The presence of consumers' taps and branch connections increases the difficulty of cleaning a line. After a pipe line has been cleaned, it is sometimes necessary to pump out the consumers' taps attached to same by means of a force pump for the reason that the particles dislodged in the interior of a pipe line may be forced into the corporation cocks. Branch connections and valves are sources of possible difficulty in cleaning a line by reason of the possibility of the cleaner sticking at such points. Having all this information available, it is usually possible to forecast the probable benefits of cleaning.

Cleaning Uncoated Pipe.—The writer's first experience in pipe cleaning was gained when two parallel lines from a reservoir to a railroad yard were cleaned. This line was particularly difficult, as it contains many bends and is of various sizes, the exact location of the reducers being then unknown. Some of this pipe was laid in the fifties and sections removed indicated that it was uncoated pipe, cast on the side in 9 ft. lengths. Before this line was cleaned, it carried a little more than half the theoretical capacity, while, after cleaning, this was increased to nearly 90 per cent. The other line from the same reservoir was 20 or 30 years old and is the usual 12 ft. coated pipe. Its capacity was increased from two-thirds to more than 90 per cent of that of new pipe. Such results are most encouraging. The unfortunate feature is that the results were not permanent and, about 5 years later, the capacity had decreased to approximately what it had been before cleaning. As the uncoated pipe had no protection at all, it is natural that it should have corroded rapidly following cleaning. This is an unusual condition, which, fortunately, is not often encountered.

Capacity Doubled by Cleaning.—The capacity of a pipe line approximately 3 miles long, half of which was 10 in., about 30 years old, the balance 12 in., 20 years old, was known to be inadequate and on investigation it was determined that this was due not only to tuberculation 1 in. thick in the 10 in. portion, causing a material reduction in area, but also to serious leakage in two creek crossings which did not show on the ground. In cleaning the 10 in. line, a joint missed at the first pouring was encountered. The lead in the pipe weighed about 50 lb. and measured 4 ft. along the bottom of the pipe. The cleaner picked this up and rolled a portion of it into a ball until the weight was so great as to stop the cleaner under the low water pressure available. As a result of this, it was necessary to cut the line to remove the cleaner. Due to the cleaning and reduction in leakage, the capacity was more than doubled, so that it was nearly equal to that of a new line. All of this increase in capacity can be credited to the job, as the leakage would not have been found unless cleaning had been done. A further result of this cleaning was that it was possible to discontinue the operation of a pumping station which was originally installed as an emergency or stand-by unit, but due to the decreased capacity of the line, it was necessary to operate the station continuously for some time.

Other Difficulties Located by Cleaning.—Another line cleaned was approximately 5 miles long. The available head was so low that there was not sufficient pressure to force the cleaner through the line. Rather than pull it through by means of a winch, a temporary boiler and pump were set up and water pumped into the line at a pressure sufficient to move the cleaner. In this way, the line was successfully cleaned and the capacity was greatly increased. As in the last case, this increase in capacity was sufficient to enable the discontinuance of a pumping station, which had originally been installed as an emergency unit, but had become practically a permanent installation by reason of the decreased capacity of the gravity line. The blow-off valves and automatic air vents on this pipe line had not been properly maintained, and were therefore not functioning. It was found that there was a considerable accumulation of sediment at the low points and that the capacity of the line was further reduced by air binding at the summits. Here again, while all of the increase in capacity was not due to the passage of the cleaner through the line, it is believed that all of the benefits are properly to be credited to the cleaning operation, for, if this had not been undertaken, the other difficulties would not have been located and it would have been necessary to continue the operation of the pumping station.

At another point, the discharge from a pumping station to a reservoir, consisting of parallel lines of 12 in. and 16 in. pipe, approximately 15 years old, was investigated, and it was decided to clean both lines, starting with the 12 in. After this was done, it was found that the 12 in. was carrying a much larger percentage of the flow and that the capacity had but increased approximately 30 per cent. These figures indicated that the cost of cleaning the 16 in. pipe line was unwarranted, as the reduction in pumping head which could have been accomplished by pumping through a clean line would not have decreased the fuel bill sufficiently to warrant the cost. The performance of this system is being observed and the 16 in. line will be cleaned as soon as capacity becomes a controlling feature or the possibilities of fuel saving become attractive. This line contained comparatively few tubercles, some of which were quite large, reaching a diameter of 1 in. and a height of ⅝ in. At one point in the line the cleaner was stopped by a small stone wedging between the cleaner and the seat ring. Upon removing the bonnet it was possible to pry the cleaner loose and the stone was removed. At another point a "missed" joint was encountered, the lead having spread out to a length of approximately 4 ft. and contained almost sufficient lead to run two joints. The water carried in this line is filtered. The total solids are always quite low and the alkalinity of the raw water seldom exceeds 12 to 15 parts per million, while in the spring it becomes very low. This water, while it is of a very desirable quality as to its total solid content, it is also very active and attacks the pipe line quite rapidly.

Another job consisted of cleaning 4 miles of 12-in. line, approximately 20 years old, the frictional loss through which before cleaning was nearly three times that of new pipe, and after cleaning, approximately the same as that of new line. The capacity was increased by approximately 35 per cent and the delivery pressure by 20 lb. under normal operating conditions. It would have been possible to obtain a greater increase in capacity by delivering at the same pressure, but the increase in pressure was a very desirable feature under the operating conditions. In cleaning this line, an axe complete with handle was recovered, also an iron wedge from a gate valve and a number of stones of various sizes, several of which were quite large.

Booster Station Discontinued as Result of Cleaning.—A 10½ mile section of 16-in. pipe line in the same system was also cleaned. As a result of this cleaning it was possible practically to discontinue the operation of a booster pumping station for the delivery without pumping after cleaning was greater than the delivery with pumping before cleaning. The gravity delivery of this line was increased 60 per cent. By reason of the increased flow, the percentage of increase when boosting after cleaning was only 30 per cent. The testing done in connection with this work disclosed the existence of two serious leaks along the pipe line, of which there was no indication on the surface of the ground. The tests also disclosed the existence of a valve of which there was no previous record. This valve was nearly closed, and under maximum delivery caused a material loss of head through the pipe line. The increase in capacity was therefore not due entirely to cleaning of the line, but was also due to the elimination of the leaks and the excessive loss of head.

The capacity of a 4 in. pipe line a mile long supplying a small railroad water station was found to be so reduced that

the laying of a new line was contemplated, but by cleaning a capital expenditure was avoided. The loss of head available in this line was so small that it was necessary to pull the cleaner through, at which time it was found that a summit was practically level with the intake, and the low points had material quantities of sediment. The cleaning was done in the winter time when the ground was covered with a foot of snow. The location of this pipe line was not known definitely, and it was necessary to prospect for same. As a result of this, the cost of the work was at least double what it should have been. The increase of 40 per cent in capacity is sufficient to obviate the necessity of renewing the line for a considerable period in the future.

Cleaning 22 Miles of 16 Year Old Pipe.—During the past summer 22 miles of 12 in. trunk line have been cleaned. The cleaned line consisted of three sections, the longest of which is more than 13 miles. The increase in capacity due to cleaning this portion was approximately 35 per cent. The unit length cleaned was governed by the location of a number of 90° bends, through which it was not considered advisable to attempt to pass the cleaner. These units ranged in length from ½ to about 4 miles.

The second section of this line, more than 3 miles long, was cleaned with similar gratifying results. In this section the pressure was low, and considerable difficulty was experienced in cleaning on that account. Under certain conditions there was practically no flow previous to cleaning. After cleaning, under similar conditions, the flow was approximately 350,000 gal. per day. The percentage increase in such cases is hardly a fair criterion, but this improved condition is of the greatest value in the operation of the line.

Cleaning the third section of this line, which is more than 6 miles long, and carries ample pressure for cleaning, resulted in an increase in capacity of approximately 46 per cent. The cleaner successfully passed through no less than five 45° bends in this section, but did not pass through a sleeve which had been used to make a 15° bend. The ends of the pipe had not been properly brought together at this point and a large stone dropped into the space. The cleaner wedged against this and it was necessary to cut the line to remove it.

This pipe line is approximately 16 years old and carries a high quality of water which is quite active, and the tuberculation was sufficient to reduce the diameter of the line in many places. The tuberculation was not evenly distributed along the line as some sections were comparatively free, while others, as noted above, showed a reduced diameter. Cleaning this pipe line disclosed the usual number of foreign objects, including many stones, a 6 ft. piece of 2x4 in. lumber, a complete shovel and a shovel handle. No doubt the shovel itself will be recovered at some later date, probably under a valve or else by obstructing the cleaner. It seems impossible to keep such foreign objects out of a pipe line, and while it is most unfortunate that this is true, it is hardly likely that in the average case the capacity of a line is materially reduced unless they are collected at a critical point, such as a valve or bend.

These 22 miles of pipe line which were cleaned comprise the critical sections in a 48 mile length of 12 in. line. The benefits derived consist not only in the increased capacity, but an important item was in reducing outside purchases of water. There are comparatively few points along this line where water can be purchased. None of the available waters are equal in quality to the water carried by the line and they are also more corrosive and expensive.

Approximately 3 miles of 10 in. pipe line has been cleaned very recently. The water supply at this point is obtained from a large river which is always quite hard and frequently acid. In order to correct these conditions, the water is treated constantly without sufficient sedimentation capacity. As a result of this, the treated water is not properly settled and precipitation occurs in the pipe line. The water is relatively inactive and there were comparatively few tubercles, but the sediment from the treating plant had formed a coating approximately ¾ in. thick throughout the line. This coating was readily removed and was discharged from the blow-offs like molasses. The increase in capacity due to cleaning was 65 per cent, while, under operating conditions, 20 per cent more water is delivered at double the former pressure.

Summarizing the situation, it is apparent from the examples cited that in many cases, pipe cleaning, especially of long transmission mains, will produce very substantial benefits where there is a deficiency in capacity or pressure. All water companies do not have the problem of long transmission mains, but those which do, in many cases, would find it to their advantage to investigate same, as actual conditions may be determined only by observations.

Charge for Resuming Water Service

The practice of various cities in regard to making a charge for resuming water service after the payment of a delinquent bill is summarized as follows in *Water Works:*

Portland, Ore., Charges $1.—Until a few years ago a nominal charge of 50 ct. was made by the Bureau of Water Works of Portland, Ore., for turning on water after a delinquent bill was paid. After checking up the matter carefully we found that a charge of 50 ct. only barely covered the actual average cost to the bureau of the inspector's time in turning off and turning on the water. In many cases the bureau lost money on the inspector's time, not to say anything about cost of transportation, such as street car fare, use of bicycles, motorcycles or automobiles. It also found that people neglected to pay bills to such an extent, mainly on account of the small fee, that too much time was spent in turning water off and on instead of doing more important work. Therefore, the charge for such service was raised from 50 ct. to $1, the amount charged at the present time. In estimating such a charge one of course must take into consideration the area of a city. Portland, with a population of nearly 400,000, covers an area of 66 square miles, whereas Los Angeles, with a population of over a million people, covers an area of 355 square miles. We divide the city into three districts, namely the west side, east side and Albina or northeast district. Everything on the west side is handled from the city hall. East side and Albina districts are handled from separate city owned buildings with direct telephone wires to the city hall. A chief inspector and a crew of 32 inspectors do all the work of turning on and shutting off water, reading meters, inspecting for leaks, etc.—L. S. Kaiser, Superintendent Bureau of Water Works.

A 50 Ct. Charge at Indianapolis.—The Indianapolis Water Co.'s charge for turning on water after a delinquent bill is paid is usually 50 ct. Our rules approved by the Indiana Public Service Commission, permit us to charge $1 for this service. For years the charge has been limited to 50 ct. excepting in very unusual cases of chronic non-payment of bills. Of course it costs us more than 50 ct. considering the time of the man and truck to turn on the water, but 50 ct. seems to be the practice in this area—the other utilities, gas, electric light, etc., making this same charge.—H. S. Morse, Manager Indianapolis Water Co.

Charge at Cambridge, Mass.—The regulations of the Water Board at Cambridge, Mass., provide that a charge of $1 be made for turning on the water after it has been shut off for non-payment of bill.—T. W. Good, General Superintendent.

New Orleans Charges 50 Ct.—The regulations of the Sewerage and Water Board of New Orleans, La., provide for charge of 50 ct. for turning off and on of water and a 10 per cent addition to bills in case of delinquent bills. These charges, however, do not cover the cost of the items. There are an astonishing number of people whose cost for the collection of delinquent bills exceeded the delinquent fee charges by something like $6,000 last year. New Orleans water rates as now existing were made in 1913, and have been held as they now stand by legislative restriction, and 1926 conditions are somewhat different from 1913 conditions.—Geo. G. Earl, General Superintendent Sewerage and Water Board.

Practice at New Bedford, Mass.—The regulations of the water department provide that on bills remaining unpaid for 30 days a demand is issued for which a charge of 50 ct. is made. Fifteen days after this, if the bill still remains unpaid the water is shut off and not turned on again except on the payment of all prior charges plus $2. In view of the fact that it is necessary to visit the property once to shut off the water and again to turn on, also the extra office work involved, $2 does not seem to be too great a charge. Sixty days after date of bill the charge becomes a lien on the property and the expense of recording and discharging is added. The amount is usually $1.40.—S. H. Taylor, Superintendent.

$1 Charge at Jacksonville, Fla.—For many years past the city of Jacksonville, Fla., has charged $1 on account of turning off of service when the bill is unpaid. We also have a ruling that should the water be turned off and the customer turns it back on without authority, we take the meter out and make a charge of $3 in addition to paying the regular bill.—J. E. Pace, City Auditor.

Delinquency Charges at Somerville, Mass.—In cases of non-payment of water charges within the specified time the supply will be shut off and water will not again be let on until the charges along with $1 costs have been paid. Costs will be charged where the water has been ordered shut off for non-payment, though the bill be paid before the supply has been actually shut off.—Frank E. Merrill, Water Commissioner.

$1 for Turning Off and $1 for Turning On at Houston.—The city ordinance of Houston, Tex., containing the following regarding the "on and off" water charge: "In case the water has been turned off on account of waste or unauthorized use of same the water commissioner shall charge and collect the further sum of one dollar for turning off and one dollar for turning on."—Jas. H. B. House, Water Commissioner.

How Delinquent Bills Are Handled at Dallas.—The city ordinance provides a charge of $1 where the water is turned off for non-payment, and I believe that this is a just charge for this; however, the board of commissioners has seen fit to make this 75 ct. instead of $1, and this we collect in nearly all instances.—Jennings M. Moore, Secretary and Collector Dallas City Water Works.

$1 Charge at Tulsa, Okla.—The Water Department of Tulsa, Okla., makes a charge of $1 for turning on water after delinquent bill is paid. We feel that this a reasonable charge, inasmuch as the patrons would take advantage if we did not make a charge of this nature. The Water Ordinance of the city contains the following provisions regarding the payment of water bills:

"That all meters shall be read monthly and all service charges and water bills shall be due and payable monthly, at the office of the Commissioner of Water Works in the Municipal Building of the City of Tulsa, as hereinafter provided, to-wit:

"District No. 1 as above defined shall be mailed to such consumers not later than the 1st day of each month and such bills shall be paid not later than the 10th day of the month succeeding the end of the monthly period upon the basis of which the charge is made.

"District No. 2, as above defined shall be mailed to such consumers not later than the 8th day of each month, and such bills shall be paid not later than the 18th day of the month succeeding the end of the monthly period upon the basis of which the charge is made.

"District No. 3, as above defined shall be mailed to such consumers not later than the 17th day of each month, and such bills shall be paid not later than the 27th day of the month succeeding the end of the monthly period upon the basis of which the charge is made.

"In the event of the failure of any consumer to make payment of charges assessed against him on or before the date fixed herein such charge shall then become delinquent and a penalty of ten (10%) per cent of the amount due, shall be added thereto and service to such consumer may be discontinued without notice to him, in which latter event, charge of $1.00 will be assessed for shuting off and turning on water. The failure of any consumer to receive a statement of the amount of the charge due from him shall not constitute an excuse for the neglect, failure or refusal to pay the charge assessed against him when the same is due."—W. F. Anderson, Superintendent Water Department.

$2 Charge at Boston.—The Water Division of the Public Works Department of Boston, Mass., makes a charge of $2 for turning on water after a delinquent bill has been paid. This is added to the amount of the bill by the city collector, when payment is made. The receipted bill is then shown to the water income branch where an order is isued to the operating branch to turn on the water. The sum of $2 is a nominal charge, as under present working conditions, it does not cover the entire cost of the operation which includes—notification, shutting off, letting on, clerical work, etc., etc. In the olden days that amount of money practically covered the cost, but with increased wages and costs all along the line it now falls short. We consider the collection of the charge, not only as a partial reimbursement for the expense of collecting the bill, but also as a deterrent of delinquency. Whether it operates successfully in the latter capacity, I am not sure as my opinion is that delinquency is a chronic malady. We have the same old names regularly. It is a habit, and a bad one at that.—George H. Finneran, Superintendent.

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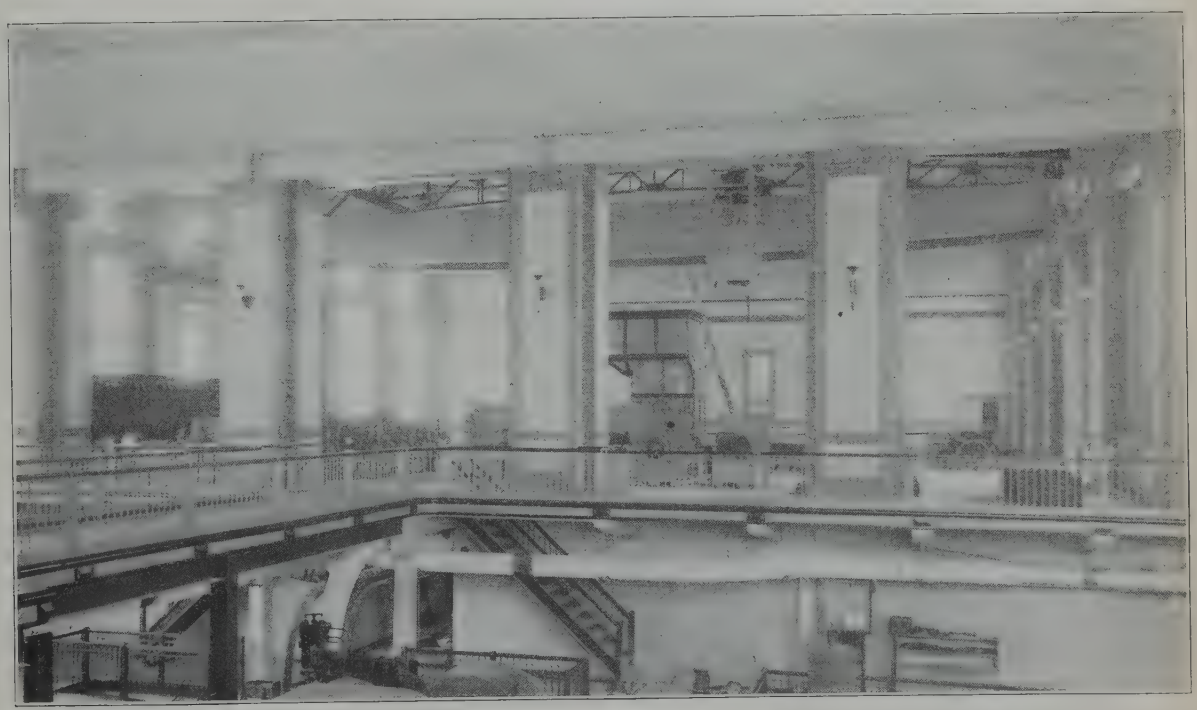

Engine Room, Howard Bend Plant, St. Louis City Water Works
Dunham Construction Co., General Contractors

Study & Farrar, Architects

Effect of Growth in Population on Water Consumption for Various Cities

From Water Works

		City	Period of Years		Per Cent of Services Metered		Population			Total Consumption (m g d)			Per Capita Consump. (Gallons per Day)			Meter Rates				
			Years Taken	Length of Period	Beginning	End	Beginning	End	Annual Increase in % (Compounded Annually)	Beginning	End	Annual Increase in % (Compounded Annually)	Beginning	End	Annual Increase in % (Compounded Annually)	Minimum Charge Monthly	Minimum Charge Annual	Domestic Rate per 1000 gals	Intermediate Rate per 1000 gals	Mfg Rate per 1000 gals
GROUP No. 1 (Present Population over 1,000,000)	1	DETROIT, MICH	1920-24	4	97	99	1,066,000	1,372,000	6 6	152 0	184.0	4 9	143	134	-1.5	$0.42	$5.00	$0.10	$0.08	$0.06
	2	MASS METROPOLITAN DIST.	1913-24	11	58	95	1,110,000	1,300,000	1 4	103 8	124.1	1.7	94	95	0.1	0.67	8 00	0.21	0.19	0 18
	3	CLEVELAND, O	1908-24	16	94	98	519,000	1,074,000	4 7	52 1	151.2	6.9	100	141	2.2	0 50	6.00	0 08	0.08	0 08
		Straight average for Group No.1		10	83	97	898,000	1,249,000	4 2	102.6	153.1	4.5	112	123	0.3	0.53	6 33	0.13	0 12	0.11
GROUP No. 2 (Present Population between 250,000 and 1,000,000)	4	BOSTON, MASS	1913-24	11	41	94	733,000	788,000	0 6	79.4	87.7	0.9	108	111	0.3	0 67	8.00	0 21	0.19	0 18
	5	SAN FRANCISCO, CA.	1919-24	5	100	100	565,000	610,000	1 6	35.7	39.3	1.9	63	64	0.4	0.78	9.36	0.40	0.33	0.30
	6	MILWAUKEE, WIS.	1901-24	23	89	99	300,000	550,000	2 7	24 0	69 0	4.7	80	125	2.0	0.17	2.00	0 10	0 09	0 09
	7	NEWARK, N.J.	1917-24	7	88	96	418,000	446,000	1 0	45 6	45.6	-0 6	109	98	-1.5	0.50	6.00	0.15	0.14	0.13
	8	CINCINNATI, O	1914-24	10	61	100	397,000	425,000	0 7	50 8	48 9	-0 4	128	115	-1.1	0.40	4 80	0 16	0.18	0.16
	9	MINNEAPOLIS, MINN	1908-24	16	76	100	277,000	417,000	2 6	17 8	42.8	5.6	64	102	2.9	0 33	4 00	0 08	0.08	0 08
	10	NEW ORLEANS, LA	1918-24	6	100	100	389,000	412,000	1 0	35 2	45 4	5.4	85	110	4.3	0 25	3.00	0.11	0 09	0 07
	11	KANSAS CITY, MO.	1916-24	8	70	83	315,000	384,000	2.5	32.7	48.3	5.0	104	126	2.4	0 70	8.40	0 22	0 17	0.11
	12	ROCHESTER, N.Y.	1908-24	16	87	99	202,000	309,000	2 7	17 6	26.4	2.6	87	86	-0.1	0 50	6.00	0.18	0.17	0.15
	13	PROVIDENCE, R.I.	1902-24	22	84	95	198,000	284,000	1 6	11 6	23 6	3.3	58	83	1.6	0 67	8 00	0 24	0 17	0.11
	14	TOLEDO, O	1910-24	14	85	100	168,000	282,000	3.8	15.6	29	4.5	93	102	0.7	0.71	8 50	0.13	0 12	0.11
	15	ST PAUL, MINN	1914-24	10	85	99	225,000	280,000	2 2	13 5	20.4	4.2	60	73	2.0	0 30	3 60	0 09	0 09	0 09
	16	COLUMBUS, O	1910-24	14	91	99	182,000	270,000	2 8	13.8	23 2	3.8	76	86	0.9	0.40	4 80	0 16	0.16	0.15
		Straight average for Group No.2		12	81	97	336,000	420,000	2.0	30.1	42.1	3.1	86	99	1.1	0.49	5.88	0.17	0.15	0.13
GROUP No. 3 (Present Population between 100,000 and 250,000)	17	SAN ANTONIO, TEX.	1913-24	11	27	60	120,000	210,000	5.2	12.6	23 0	5.7	105	109	0.4	0.80	9.60	-	-	-
	18	WORCESTER, MASS	1896-1924	28	93	98	103,000	192,000	2 2	6.1	16 3	3.6	60	84	1.3	0.33	4 00	0 20	0.15	0.10
	19	HARTFORD, CONN.	1905-24	19	99	100	91,000	182,000	3.7	6.2	16.2	5.2	69	89	1.3	-	-	0.16	0.16	0.10
	20	DAYTON, O	1917-24	7	81	87	141,000	170,000	2.8	12.7	16.7	3.9	90	98	1.2	0.55	6 60	0 13	0.09	0.07
	21	GRAND RAPIDS, MICH.	1915-24	9	75	100	125,000	160,000	2 8	10.5	15.9	4.8	84	99	1.9	0.67	8 00	0 09	0.09	0 09
	22	SPRINGFIELD, MASS.	1913-24	11	94	99	99,000	151,000	3 9	10.7	13.5	2.1	108	89	-1.8	0 67	8 00	0 18	0.08	0 07
	23	NEW BEDFORD, MASS.	1914-24	10	96	93	108,000	145,000	3 0	7.4	9.7	2.7	69	67	-0.3	0.42	5 00	0 16	0.10	0.10
	24	FALL RIVER, MASS	1900-24	24	94	100	108,000	131,000	0 9	3.8	6.8	2.5	35	52	1.7	-	-	0 28	0.20	0.14
	25	LOWELL, MASS.	1909-24	15	77	90	105,000	125,000	1.2	5.2	6.5	1.5	50	52	0.3	-	-	0.28	0.28	0.28
	26	YONKERS, N.Y.	1909-24	15	100	100	76,000	110,000	2.5	7.6	13.4	3.8	100	122	1.3	0 67	8 00	0 21	0.13	0.13
	27	LAWRENCE, MASS.	1905-24	19	88	97	69,000	103,000	2.1	3.0	4 6	2.3	43	45	0.3	0.58	7 00	0 20	0.20	0.20
	28	SOMERVILLE, MASS	1913-24	11	61	94	83,000	101,000	1.8	6.0	7.8	2.4	72	77	0.6	0 50	6 00	0 16	0.16	0 12
		Straight average for Group No. 3		15	82	93	102,000	148,000	2.7	7 6	12.5	3.4	74	82	0.7	0.58	6.91	0.19	0.15	0.13
GROUP No. 4 (Present Population between 25,000 and 100,000)	29	BROCKTON, MASS.	1911-24	13	100	100	69,000	84,000	1.5	2.7	4.2	3.5	39	50	1.9	-	-	0 26	0.16	0.14
	30	MANCHESTER, N.H.	1904-24	20	70	85	62,000	83,000	1.5	3.1	6.4	3.7	50	77	2.2	0.67	8.00	0.13	0.13	0.10
	31	MALDEN, MASS.	1913-24	11	99	99	48,000	53,000	0.9	2.23	2 86	2.3	46	54	1.4	0.58	7 00	0.21	0.20	0.19
	32	QUINCY, MASS	1913-24	11	86	91	36,000	53,000	3.6	2.7	4.4	4.5	76	82	0.7	1.17	14.00	0 31	0.24	0.19
	33	WOONSOCKET, R.I.	1895-1923	30	86	96	23,000	51,000	2.7	0.6	3.1	5.6	24	60	3.1	0 83	10.00	0 28	0.14	0.10
	34	MADISON, WIS.	1897-1924	27	89	100	18,000	48,000	3 7	0.8	4.8	6.9	44	102	3.2	-	-	0.12	0 09	0.06
	35	CHELSEA, MASS.	1913-24	11	98	100	36,000	47,000	2 5	2 88	3.55	1 9	80	76	-0.5	0 50	6 00	0.15	0.15	0.15
	36	MEDFORD, MASS	1913-24	11	100	100	26,000	46,000	5.3	1.2	2.4	6.5	48	53	0.9	0.50	6.00	0 20	0.16	0 16
	37	EVERETT, MASS.	1913-24	11	40	89	37,000	44,000	1.6	2.4	4.5	5.9	65	102	4.2	0.50	6.00	0.16	0.15	0 12
	38	TAUNTON, MASS	1905-23	18	46	88	28,000	37,000	1.6	1.9	3.6	3.6	69	99	2.0	0.75	9.00	0.25	0.18	0.11
	39	WALTHAM, MASS.	1919-24	5	91	100	31,000	33,000	1.2	1.9	2.2	3.0	61	66	1.6	0 83	10.00	0.22	0.15	0.15
	40	REVERE, MASS.	1913-24	11	50	87	21,000	31,000	3 6	1 39	2.29	4.7	67	74	0.9	0 83	10 00	0.19	0.15	0.15
	41	WATERTOWN, MASS	1913-24	11	100	100	14,000	26,000	5.8	0.87	1.66	6.1	62	65	0.2	0 83	10 00	0.33	0.30	0.22
		Straight average for Group No 4		15	81	95	35,000	49,000	2.7	1.9	3.5	4.5	56	74	1.7	0.73	8.73	0 22	0.17	0.14
GROUP No. 5 (Present Population below 25,000)	42	ARLINGTON, MASS	1913-24	11	100	100	13,000	24,000	5 8	0 79	1.40	5 3	63	59	-0.5	1.25	15 00	0 20	0.16	0.14
	43	MELROSE, "	1913-24	11	100	100	17,000	19,000	1.0	1.14	1.25	0.9	68	64	-0.5	0.75	9 00	0 22	0.20	0.20
	44	WINTHROP, "	1913-24	11	100	100	11,000	18,000	4 6	0 69	0 97	3.2	60	55	-0.7	1.00	12 00	0 24	0.24	0.24
	45	MILFORD, "	1910-24	14	57	89	15,000	16,000	0 5	0.8	0.9	0 9	51	56	0.7	1.00	12.00	0 53	0.25	0.21
	46	BELMONT, "	1913-24	11	100	100	6,300	14,000	7 5	0 46	0.89	6.2	73	64	-1.2	0.83	10.00	0 24	0.20	0.20
	47	MILTON, "	1913-24	11	100	100	8,500	11,000	2 3	0.33	0 54	4 6	39	47	1.7	1.00	12 00	0 33	0.33	0.33
	48	SWAMPSCOTT, "	1913-24	11	100	100	6.600	8,400	2.2	0.42	0.73	5.2	63	87	3.0	0 92	11 00	0 40	0.40	0.40
	49	STONEHAM, "	1913-24	11	87	100	7,800	8,200	0 5	0.41	0 60	3.5	53	73	3.0	0.83	10 00	0.43	0.32	0.26
	50	LEXINGTON, "	1913-24	11	79	100	5,400	7,000	2 4	0 36	0.45	2.1	67	64	-0.4	1.00	12 00	0 30	0.22	0 20
	51	NAHANT, "	1913-24	11	60	94	1,400	1,600	1 2	0.17	0 20	1.5	123	126	0.2	0 83	10.00	0 25	0.25	0.25
		Straight average for Group No. 5		11	88	98	9,200	13,000	2.8	0.56	0.79	3.3	66	70	0.5	0.94	11.30	0.31	0.26	0.24
GROUP No. 6 Mass. Metropolitan Water District	4	BOSTON, MASS.	1913-24	11	41	94	733,000	788,000	0 6	79.4	87.7	0.9	108	111	0.3	0.67	8.00	0.21	0.19	0.18
	28	SOMERVILLE, "	1913-24	11	61	94	83,000	101,000	1.8	6.0	7.8	2.4	72	77	0.6	0.50	6.00	0 16	0.16	0.12
	31	MALDEN, "	1913-24	11	99	99	48,000	53,000	0.9	2 23	2 86	2 3	46	54	1.4	0 58	7 00	0 21	0 20	0.19
	32	QUINCY, "	1913-24	11	86	91	36,000	53,000	3.6	2.7	4.4	4.5	76	82	0.7	1.17	14.00	0 31	0.24	0.19
	35	CHELSEA, "	1913-24	11	98	100	36,000	47,000	2 5	2 88	3.55	1 9	80	76	-0.5	0 50	6.00	0.15	0 15	0.15
	36	MEDFORD, "	1913-24	11	100	100	26,000	46,000	5.3	1.2	2.4	6.5	48	53	0.9	0.50	6 00	0 20	0.16	0.16
	37	EVERETT, "	1913-24	11	40	89	37,000	44,000	1 6	2 4	4 5	5 9	65	102	4.2	0 50	6 00	0 16	0.15	0.12
	40	REVERE, "	1913-24	11	50	87	21,000	31,000	3 6	1.39	2 29	4.7	67	74	0.9	0 83	10.00	0 19	0.15	0.15
	41	WATERTOWN, "	1913-24	11	100	100	14,000	26,000	5.8	0.87	1.66	6.1	62	65	0.2	0 83	10 00	0 33	0 30	0.22
	42	ARLINGTON, "	1913-24	11	100	100	13,000	24,000	5 8	0.79	1.40	5 3	63	59	-0.5	1 25	15 00	0 20	0 16	0 14
	43	MELROSE, "	1913-24	11	100	100	17,000	19,000	1.0	1.14	1.25	0.9	68	64	-0.5	0.75	9 00	0 22	0 20	0.20
	44	WINTHROP, "	1913-24	11	100	100	11,000	18,000	4 6	0 69	0 97	3 2	60	55	-0.7	1 00	12 00	0 24	0 24	0 24
	46	BELMONT, "	1913-24	11	100	100	6,300	14,000	7 5	0 46	0 89	6 2	73	64	-1.2	0 83	10 00	0 24	0 20	0 20
	47	MILTON, "	1913-24	11	100	100	8,500	11,000	2 3	0 33	0 54	4 6	39	47	1.7	1 00	12 00	0 33	0 33	0 33
	48	SWAMPSCOTT, "	1913-24	11	100	100	6.600	8,400	2.2	0.42	0.73	5.2	63	87	3.0	0 92	11 00	0 40	0 40	0 40
	49	STONEHAM, "	1913-24	11	87	100	7,800	8,200	0 5	0.41	0 60	3.5	53	73	3.0	0 83	10 00	0 43	0 32	0 26
	50	LEXINGTON, "	1913-24	11	79	100	5,400	7,000	2 4	0 36	0 45	2 1	67	64	-0.4	1 00	12 00	0 30	0 22	0 20
	51	NAHANT, "	1913-24	11	60	94	1,400	1,600	1 2	0.17	0 20	1.5	123	126	0.2	0 83	10 00	0 25	0 25	0 25
		Straight average for Group No. 6		11	83	97	62,000	72,000	3.0	5.8	6 9	3 8	69	74	0.7	0 81	9 67	0 25	0 22	0 21
		MASS METROPOLITAN DIST	1913-24	11	58	95	1,110,000	1,300,000	1.4	103 8	124 1	1 7	94	95	0.1			0 21	0 19	0 19
GROUP No. 7 (Cities with small % of metering)	52	NEW YORK CITY, N.Y.	1920-24	4	27	25	5,664,000	6,015,000	1 5	734 9	789.2	1.7	130	131	0.2	-	-	0 13	0 13	0.13
	53	ST LOUIS, MO	1912-24	12	7	8	711,000	811,000	1.1	83.5	113.1	2 6	120	140	1.3	0.17	2 00	0.17	0 10	0 07
	54	INDIANAPOLIS, IND	1910-24	14	11	23	237,000	362,000	3.1	19 3	32.4	3.8	81	90	0.8	1 40	16 80	0 19	0 16	0 09
		Straight average for Group No. 7		10	15	19	2,204,000	2,396,000	1.9	279.2	311.6	2.7	110	120	0.8	0 78	9 40	0.16	0.13	0 10

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HAUCK MANUFACTURING COMPANY

Established 1900

141 Tenth Street, Brooklyn, N. Y.

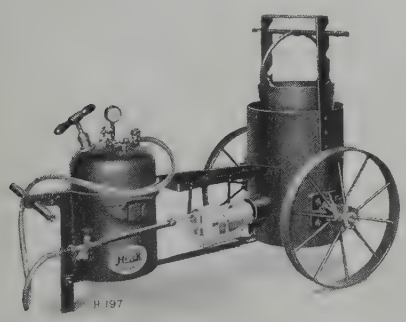
Oil Burners and Oil Burning Equipments

Products: Kerosene Lead and Compound Melting Furnaces and Torches for Melting Lead Out of Pipe Joints; Steam Thawers; Weed Burners.

Also Asphalt Surface and Tool Heaters; Asphalt Pitch and Tar Melting Kettles; Circular and Straight Flame Kerosene Burners for heating kettles; Concrete Heaters; Thawers; Oil Burning Salamanders and Water Heaters; Kerosene Torches of all sizes.

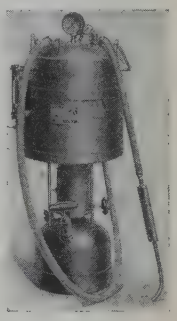
The Hauck Combination Lead Melting Furnace and Torch—on legs—burns kerosene and is made in two sizes—200 lbs. (as illustrated) and 450 lbs. capacity. Melts 200 lbs. of lead in 10 minutes; 450 lbs. in 20 minutes. The torch equipment is instantly detachable for melting lead out of pipe joints and general heating and repair work. Both furnaces are equipped with the new "slide-rail" HEAT CONTROL—an exclusive Hauck feature. For full heat, simply push burner forward on "slide-rail"; for less heat, pull burner away from furnace. Send for bulletin No. 101.

The Hauck Combination Lead Melting Furnace and Torch on Roller-Bearing Wheels—burns kerosene and is made in three sizes, 200 lbs. 450 lbs. (as illustrated) and 850 lbs. capacity. Melting time for small sizes as above; 850 lbs. in 35 minutes. These furnaces are also equipped with the new "slide-rail" HEAT CONTROL—an exclusive Hauck feature, as described above. Ask for bulletin No. 101.



The Hauck Asphalt Tar and Pitch Kettles made in two sizes—50 and 100-gallon capacity, on steel and rubber-tired wheels. Ask for special bulletin.

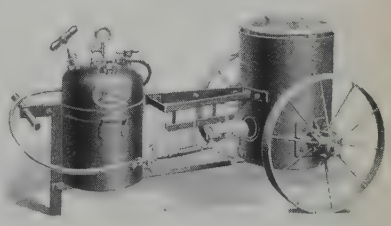
The Hauck Steam Thawing Outfit illustrated is very popular with Water and Fire Departments for thawing out frozen water hydrants and pipe lines (burns gasoline or kerosene as specified). Raises steam in four minutes. Operates 40 minutes steadily. Steam generator capacity 3 gallons. Furnace tank capacity 1½ gallons. Also made in 10-gallon steam generator size, on wheels. Send for special Steamer bulletin.



The Hauck Weed Burners burn kerosene. Made in a number of sizes for hand, "one-man" and "two-men" use. Burn weeds just as they stand, green, on the stalk. Destroy the seeds. Get into all kinds of places. Great labor-savers. Send for bulletin No. 1013.

The Hauck Compound Melting Furnace on Legs for Leadite, Hydrotite, G-K Sewer Joint and other compounds (burns gasoline). Three burners are used for melting initial batch; thereafter only one or two burners are used. Average fuel consumption per 8-hr. day, 2¾ gallons. Cast iron pot holds approximately 120 lbs. compound; 8 gallons liquid. Send for bulletin No. 102.

The Hauck Compound Melting Furnace on roller-bearing wheels for Leadite, Hydrotite, G-K Sewer Joint and other compounds (burns gasoline or kerosene as specified). Cast iron pot holds approximately 120 lbs. compound; 8 gallons liquid. Equipped with the new "slide-rail" HEAT CONTROL — an an exclusive Hauck feature, as described under Lead Melting Furnaces. Ask for bulletin No. 102.



Kinks for the Water Works Superintendent

Many practical and time saving kinks in the water works field, often original ideas of the operating man, remain untold because to the inventor they either seem too simple or he does not have the time or inclination to write them up. However, many water works operators have realized the value of exchanging experiences and in the following pages we are reprinting from *Municipal News and Water Works* a number of kinks brought out at these discussions.

Paper Wad Method of Cleaning Service Pipe.—In Worcester, Mass., we use cement lined pipe for houses and other purposes up to 1¼-in. pipe, all the pipe lined by our own men. The pipe itself practically never shows any corrosion. Corrosion shows at tees, inside wall and at gooseneck and corporation at main. On relieving of pressure we run ⅛-in. gas pipe rods out to the gooseneck, cleaning the service thoroughly, should there be corrosion at any couplings. If we do not get satisfactory pressure then, we then take a small wad of toilet paper, inserting it into the service pipe, and then attach a Blake & Knowles force pump, forcing the wad of paper through the service until we have pressure on the pump of at least five or more pounds more than the pressure on the main at that point. When we have the pressure on the pump at the point that we want to force the wad through the corporation stop, a man will open the stop at the main and with the wad of paper and the pressure up to the stop at main it requires very little pumping to force the wad through the corporation cock, where it will dissolve in the main. After that is done, owners have an ample supply at meters for a number of years again. We have been cleaning service pipes for a number of years in this way with perfect results.—Joseph A. Hoy, Worcester, Mass.

Ridding a Reservoir of Tadpoles.—In the city of Wilmington, N. C., we have just an open reservoir. Last summer I noticed an accumulation of tadpoles and how to get rid of them was a question. I was talking to an old fisherman who hangs out at our place occasionally and he told me to get some trout and put them in the reservoir. I got the trout and put them in and in less than one week's time you would never know there was a tadpole in the reservoir. We never have any algae growth in our basins at all because we draw out every day about 5 or 6 ft. and at night when the peak load is off, we fill it up again. We still keep those fish and they look every day for nourishment. If anyone is bothered with tadpoles or algae growth, I would suggest they use trout, as these trout will clean the place right up. They are good housekeepers.—J. H. Sweeney, Wilmington, N. C.

Value of Laboratory Data at Filter Plant.—It is valuable to have data at each plant, showing the character of the water put out at any particular time. Suppose a typhoid epidemic should occur at Salisbury. If you had no data regarding the bacteriological quality of the Salisbury water for the month preceding the outbreak, except for the monthly sample submitted to the State Laboratory, Mr. Craig would have no data to submit before a jury to prove that the water was not capable of producing disease at that time, and those who had cases of typhoid in their family might be able to recover damages. On the other hand, if he had data to support his claims for the purity of the water for weeks prior to the typhoid outbreak he would have evidence to show that the water was not capable of producing disease at the time. Plant data, showing the physical, chemical and bacterial characteristics of the water, is valuable to the superintendent of the plant and to the city, as is the collection of morbidity and morality and birth rates by the State Bureau of Vital Statistics. So you should have a certain amount of analytical work done at each plant laboratory.—J. W. Kellogg, Raleigh, N. C.

Location of Water Services.—We have had a rule for some time to put no services in except from the front of the house. We give the owner the privilege of locating the service anywhere in the front of his lot that he desires. We determine the front of his lot by the street and number by which the post office department delivers his mail. If a man happens to be on a corner and wants a service from the side, and he gets his mail according to the number on the front of the house, that is the way he has to take the service. That causes a little bit of discussion sometimes, but as a rule the man finally realizes that it is reasonable.

We put curb wells on all our services and also meters, and they are located so that we have very little trouble if anything happens. For some of the older services we have to use an electric pipe locater. We have used that to very good advantage for some of the old services where records have been lost. It works very well after you get acquainted with it.—J. E. Gibson, Charleston, S. C.

Mud Balls in Filter Beds.—I have noticed in washing out the filters that the gravel seemed to be cemented. I went down into one filter and took out the gravel and after I replaced it, I had the same trouble. The mud balls don't form all the way around but probably in two or three places a foot or more in diameter. I never let them run very long without breaking them up.

Before I started using a rod to break them up they would run probably three months without any disturbance. I have had these mud balls show up nearly the height of the trough. The water is very clear as a usual thing and I can see the bed when the filter is full, but at this time the water is a little cloudy.

I drain the water down and prepare the filter to be washed; I drain it down within 3 or 4 in.—say 4 in.—and start the wash water from there. That gives any operator, even at night, a chance to see the mud balls so he can get a rod and break them up. I also believe that has a tendency to eliminate them.

I have talked to people who have the same type of drain and they have not had the trouble that I have had. It may be in the installation more so than it is in the design.—R. G. Shell, Fayetteville, N. C.

Valve Operation and Maintenance.—Valves must be operated regularly to keep them in proper working condition. The Fire Underwriters require annual inspection, but in rural sections with a large percentage of unpaved streets, more frequent inspections are necessary if the valve boxes are to be kept to proper grade, ready for emergency operation. Frequently, when a shut down is attempted, one or two valves will be found leaking through, although the stems have been turned down tightly. Generally such valves can be made tight by operating them up and down, bringing the gate down into the groove hard each time and then opening the valve about one quarter way. The trouble is usually caused by the accumulation of sediment under the seat. Each time the gate is pushed down into the groove a small portion of this sediment is pushed out the sides. The high velocity of the water through the partly opened valve removes what is pushed out and the operation is repeated until the groove is sufficiently cleaned to allow the gate to seat properly, thereby cutting off the flow of water. Of course, if the groove is filled with large stone or jointing material, the valve must be dug up and taken apart for repairs. I remember operating one 16-in. valve thirty times and getting a perfectly tight shut down. The valve had not been operated for a long time, having been declared worn out since it always allowed a large volume of water to pass with the gate turned down hard with levers on the key.

With constantly changing street grades, valve boxes must be lowered and raised frequently. We use the sliding type of adjustable valve box and formerly experienced trouble in keeping the boxes to grade after changes in unimproved streets carrying heavy traffic had been made. By using two pieces of plank 12 in. long and 6 in. wide, cut to fit around the barrel of the lower section of the box in the shape of a clamp, more bearing surface is given the upper section and we now have little trouble with boxes being pushed down below grade.—Carl A. Heckmer, Salisbury, Md.

Making Out Water Bills.—We have changed our system of making out bills and it has worked so successfully that I think something ought to be said about it. We have a little over 6,300 bills to make out—water and light—and it used to take one girl practically all of her time to make these out. We have installed a Burroughs billing machine with an addressograph so that the girl is now able to issue the bills in about ten days and does not have to work very hard to do that. This machine makes three copies of the

bill—the customer's bill, the receipt stub, and our own stub and at the same time makes a copy of the bill and enters it up on a loose leaf ledger sheet which holds two years' records. It also totals up the amount of meter readings, both water and light separate, and the totals of the individual bills. We think that helps us because by comparing the meter readings at our pumping station with the total amount of water accounted for, we can get at our leakage a whole lot easier.—P. J. Dishner, High Point, N. C.

Stopping Flow from Broken Corporation Cocks.—In cases of this kind I use a long steel tool squared and tapered at each end; one end to enter the inlet end of a ¾ in. corporation cock and the other to enter the end of a 1 in. corporation cock. I insert the proper end of the tool into the brass ferrule left in the main and drive it home rather snugly. A pipe wrench will enable you to back the ferrule out of the main. Now take a closed corporation cock, insert the outlet end in the coupling of the proper size galvanized pipe and you can screw the cock into the main against the pressure. In case the main is so shallow that the force of the water coming out of the main will jet all of the water out of the hole you can use two heavy boards laid down across the hole. Cut a V-notch in each board, bring these notches together just over the hole in the main and then work down through these notches to the main. It requires a little nerve and a good grip to get the cock centered in the hole, but it can be done. I have found this was much better than cutting off the main, especially where it was a large main or one that supplied a manufacturing district. Then it is easier and cheaper. After you have inserted the cock in the main you can dig down to the cock and remove the pipe and tighten the cock with a pipe wrench.—McKean Maffitt, Wilmington, N. C.

Remedying Air Bound Filters.—I had a rather interesting experience with air bound filters. The water pumping station is five miles from the filter plant. Originally we pumped direct from the mixing chambers. Of course we had a few leaks in the line but they were not serious enough to stop the mixer. One night there was a leak and a considerable amount of air got in the pipe line. We started pumping and increasing the pressure and this air dissolved in the water so that we had a large amount of dissolved air in the water and so soon as the head got up to about 4 or 5 ft., the filter controller would then go under a negative head. Then, when the plant was shut down the filter would bubble quite vigorously and break holes larger than your fist in the surface of the filter. That would increase the bacterial count in the filter effluent.

I tried several methods to get rid of that. I thought at first that the air was in the manifold. But that did not have any effect. Since that time we have put in a raw water reservoir above the filter plant and I placed the inlets to that reservoir high up on the wall. The wall slopes and the water would flow down this wall and be about the same as an aerator on the raw water and since we put that in we have not had any air bound filters.—F. V. Fields, Mooresville, N. C.

Solving a Sewer Problem.—If any of you have charge of a sewer system this might be of interest to you. We had a sewer line to run to a section that had about twenty houses in it. To get to this section the line came to the surface of the ground. It was simply a case of leaving out this section or putting in an invert. So I tried the invert. I ran the line at the regular grade until it was within 6 in. of the surface. Then built a manhole. The inlet lines to the manhole were put 24 in below the outlet inlet lines to the manhole were put 24 in. below the outlet before it would run out. The laterals on the low line were run out to the property line before any houses were connected up. At the ends of the two low lines there were installed flush tanks so that we could get a large flush of water once in a while. In the manhole at the break in the grade we installed a 1-in. water connection in such manner that we can turn the water on and break up the accumulation of sewage that collects here. About once every two weeks in inspecting sewers we go to this manhole and break up the scum and wash it down the sewer. This line has been in operation about two years and has not given any trouble. We deemed it best to have this lie this way than to have this section of the city using separate septic tanks that were also giving trouble.—McKean Maffitt, Wilmington, N. C.

Tool for Recovering Well Rods.—To those using deep wells as a source of supply with the ordinary deep well pump I have three suggestions which have been helpful to me in a number of instances. A tool for recovering lost rods from a well has been used successfully by our forces on several occasions. It is made of a 1-in. square iron bar about 5 ft. long. The upper end is fitted with a substantial iron ring, while on the lower end a heavy piece of galvanized iron, funnel shaped, is attached. The diameter of the bottom end of the funnel varies with the diameter of the well cylinder pipe, being about ½-in. smaller, while the upper opening in the funnel should be large enough to pass the pump rod freely, but small enough to guide it through an iron loop immediately above the funnel. The funnel should be from 8 to 12 in. deep. The loop is bolted to the iron bar about 4 in. above the top of the funnel and is 2 in. wide by 3½- in. long. This loop has a sharp chisel edge

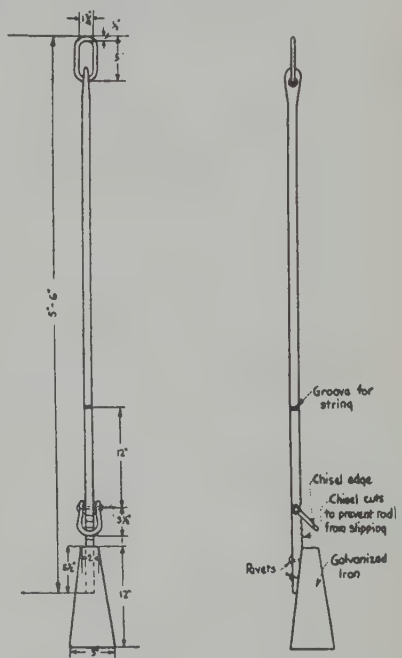


Fig 1—Tool for Recovering Well Rods

(Fig 1) to allow it to catch the pump rod securely. The end of the iron rod is tapered to fit the side of the cone.

The tool is used in the following manner. A rope, of sufficient strength to raise the lost rods and stand the added strain of pulling them through tight places while coming to the surface, is securely fastened to the ring on the upper end of the tool. The tool is then lowered into the well casing until the top of the lost rod is reached. As the lower end of the funnel is ½-in. smaller than the well casing, the upper end of the rod will pass through the funnel and the loop above it. The loop has previously been tied up with a cord, high enough to prevent the rod from passing on the outside of it, but not high enough to allow the rod to pass through it without taking the tension off the cord. The tool is now pulled toward the top of the well. The sharp edge of the ring cuts into the wooden rod sufficiently to raise the rod with it. The greater the strain put on the loop, the more deeply it cuts, and the more secure becomes the hold. Iron rods often may be caught by allowing the loop to pass below the first joint. By pulling the tool up again, the loop catches at the joint. This simple tool has saved considerable expense in eliminating the necessity of pulling the main casings to recover broken or uncoupled rods. We have successively raised twelve, 20-ft. rods with it.—Carl A. Heckmer, Salisbury, Md.

Tapping a Main.—In case you were tapping the main and should insert a corporation cock that was open you could not get the machine off the pipe without getting wet. I have done that very thing and got a good ducking from it. The next time this happened—and it will happen sometimes—I simply stripped the machine off the boring bar and

then cut off the water at the cock and removed the bar. If you be very careful, remove the collar from the top of the boring bar of the tapping machine, take the upper part of the machine off over the boring bar, then remove the lower part of the machine the same way, it will leave the cock in the main and the boring bar in the cock.—McKean Maffitt, Wilmington, N. C.

Plugging Small Holes in Wrought Iron Pipe.—Take a piece of soft white pine, taper it down to about the size of the hole in the pipe. Stick it in the hole and drive it in slightly. Draw it out and by examining the end that was in the hole you can get the exact shape of the hole. Now cut the stick so that it will have a slight taper and will be shaped almost like the hole in the pipe. Stick it in the hole and drive up rather tight. Be careful that you do not crush the stick, just tap it lightly until you have the leak stopped. Then carefully cut the stick off about ½ in. from the pipe and go home and to bed. That stick will stay there as long as the main does.—McKean Maffitt, Wilmington, N. C.

Red Water Troubles.—On Feb. 15th we appealed to the State Board of Health for help. The water was red, not only the hot water, but also the cold. The fire hydrants ran red—not slightly yellow, but red. Our first problem was to find out the nature of the compound in the water which was causing this red color. We analyzed the water and found it was iron.

We sent sample after sample to the Department of Chemistry at State College. I want to say here that his department will help any of you who need help. After analyzing the water or samples, they reported 100 per cent iron. We then took steps to stop the solution of that iron. The first thing we did was try to solve it temporarily by sodium carbonate. The results at first were terrible. There was much iron held in solution in the mains and in the city reservoir and sending up a neutral water or a slightly alkali water precipitated that whole mass all over our system. We had trouble getting it out.

The next problem was to remove the precipitated lime. We could not get the uptown department to flush, so we took the bull by the horns and went to the City Commissioners with our problem. They said, "Flush"—and we flushed for three weeks. We finally got rid of it and then waited three weeks and flushed again. Then we waited six weeks and flushed again and we have flushed periodically; each time getting a lower colored water, and now the water in the town is practically crystal clear.

We have accomplished this by the addition of only an average of ⅛ of a grain of lime per gallon. We are floccing the water at 5.2 and we have a hydrogen ion concentration of 6.8 which is acceptable from the standpoint of corrosion. However, that will require alum doses—3½ or 4 grains of alum. We are getting very satisfactory results now.—Mr. Hedgepath, Southern Pines, N. C.

Cleaning Clogged House Connections.—We have been very successful in relieving complaints of low pressure or insufficient supply in house connections, generally due to partly clogged piping, with the use of a small portable hand-pressure pump. A connection is made by means of a hose to the service pipe near the cut-off valve in the cellar and water is then pumped into the service pipe. Usually only a few quarts of water are necessary to pump the pressure up to about three times the pressure in the street main before the stoppage or accumulation of sediment will give way. It is usually not safe to pump higher, and if relief is not secured the service pipe must be dug up and replaced in the stopped section. Unless the stoppage is due to hardened encrustation, the force pump usually is effective. We always cut off the house plumbing so as not to subject any of the interior plumbing to the high pressure.—Carl A. Heckmer, Salisbury, Md.

Repairing Small Leaks in Steam Line.—If any of you run a steam plant and have a number of small leaks in your steam lines that are too small to shut down to repair, or are such that one of these patent clamps will not take care of, try this. Right at the boiler, in the horizontal pipe line, tap a small hole in the steam line. Insert a regular drip lubricator. Fill the lubricator with a mixture of cylinder oil and fine flake graphite. Make the mixture so that it will barely feed. Open the lubricator and let the mixture feed slowly into the line all the time. Attend this lubricator as regularly as you attend the lubricator on the main pump. In a few days you will fail to see any of those small steam leaks. The flake graphite will be carried into the crevices by the escaping steam and will effectually plug them up. If the graphite goes on over to the pump it will act as a better lubricator than the cylinder oil will. —McKean Maffitt, Wilmington, N. C.

Cutting Down Water Hammer.—In order to minimize the water hammer on our force mains we always close the discharge valves on centrifugal pumps slowly before shutting off the pump. However, when the pump is shut down suddenly due to accident, either the electric current failing or the power unit breaking down and the operator not having time to close the discharge valve, water hammer may cause serious damage. If the check valve holds, the main gets the full shock of the suddenly increased pressure, which on very long lines may build up to many times the normal pressure, and results in blown joints or cracked pipe. We are using pressure relief valves at our Burnt Mills Pumping Station which has a long force main leading from it. These valves are installed in manholes and set to open at fifteen pounds above maximum operating pressure. When water hammer builds the pressure up they open and prevent the pressure from going high enough to cause damage. We find it very satisfactory. With any emergency appliances care must be taken to keep them in operating condition. We operate these relief valves once each week to prevent them from becoming stuck.—Carl A. Heckmer, Salisbury, Md.

Kinks in Operation of Fire Hydrants.—Two especially simple operations are worth mentioning with regard to fire hydrant operation. Frequently a hydrant will open with difficulty during freezing weather, due to freezing of moisture in the stuffing box. Since all fire hydrants have a stuffing box the trouble can occur in any make. This usually can be overcome by tapping the operating nut with the hydrant wrench. The jar will free the stem from the packing and the hydrant will open with its usual ease. Especial care must be taken to see that the drain valve is functioning in freezing weather so the barrel will be emptied automatically each time the hydrant is used. Occasionally a stone or some clay will get into the drain hole and prevent drainage. We clear this kind of trouble by opening the main valve of the hydrant one full turn, leaving the nozzle caps on tight. As it requires about three full turns open on the main valve to completely close the drain valve on most makes of fire hydrants, the latter is still partly open on one turn. The full pressure of the water in the hydrant generally will push out any obstruction in the drain hole and the jet effect of the water through the hole will cut away the stone or earth which has packed around the outside. This simple remedy has eliminated the necessity of digging up the hydrant in most cases to correct drainage troubles.—Carl A. Heckmer, Salisbury, Md.

Locating Main Control Valves.—We have adopted the use of posts to indicate the location of main line control valves along roads in undeveloped sections where there are no houses or poles to measure from. A 3-in. pipe, 5 ft. long, capped on the upper end, is set in a small concrete base with 2 ft. bury. The body of the post is painted green and the cap light gray. An arrow and the distance to the valve is painted on the side of the post facing the valve. These valve posts are an advantage when the valve boxes are covered with mud or snow.

Repairing Blown Out Plugs.—Some years ago we had a regular siege of blown out plugs. In some few months we had five 16-in. plugs to blow out. In every case it meant shut down the plant until we could cut off the water. As our valves were not in good order at that time there was one case where we could not shut off the water tight enough to work in the hole. I got a common screw jack and some heavy gum packing. I cut a gasket 1 in. wide and the diameter of the plug, tied this gasket to the face of the plug with cotton string and then inserted the plug in the bell using the jack to force it to a seat against the gasket. This held the water tight enough for me to yarn and pour the joint. The hole was practically dry after I had jacked the plug up against the shoulder in the bell. I have used this trick several times and each time it works easier than it did the first time.—McKean Maffitt, Wilmington, N. C.

Remedies for Red Water Troubles.—Dunn had complaints from all over the distribution system of red water. When I got down there the trouble had disappeared. The Dunn plant is not run by laboratory adjustment, the operator simply adjusting his alum and alkali until he gets a floc. In looking over the records of the State Laboratory at the time of this red water trouble, we found that the water at that time had a pH around 5.6 and the same conditions that Mr. Hedgepeth just mentioned. Of course, the logical treatment was the secondary alkali to bring that pH up to neutral. When I went there we found that the pH had gone back up to 6.8 and the operator had succeeded in getting a floc by using four grains of alum to the gallon and then lime with it. This was a new plant and new filtered supply. Whenever they had to coagulate the water to get a low pH they had red water and as soon as it was possible to get a floc with pH up to 6.7 or 6.8 the red water disappeared. The recommendation was to put in a secondary alkali feed. However, they did not have that available and it was a question of providing equipment for it or using a larger amount of lime to keep the pH up and prevent red water trouble.

Another case was at Fayetteville at the old plant before it was rebuilt and there were proper facilities for getting proper operation there, we knew that lots of water went through that was not properly coagulated. In analyzing the scale there we found some evidence of aluminum hydrate mixed with it. The red water persisted. I think that red water persistency in the mains is due to the fact that there is corrosion in the mains and the scale more or less adheres to the inside of the pipe and that is gradually loosened up and washed out and it takes some period of time before you can get rid of it.

The last case was Asheboro. Asheboro has a brand new storage reservoir—a new reservoir with a lot of vegetable matter in it. That may have had something to do with the water that could be floced at a low pH and similar to the colored water in the eastern part of the state. We found in Asheboro it was not possible to get the floc unless we used alum alone and a pH reaction of 5.6. The remedy there was the installation of a secondary dry feed and with this provided, the trouble is beginning to clear up. I noticed particularly as Asheboro the carbon dioxide is very high—about 20-27 p. p. m. and when they brought the pH above 7.0 it reduced the carbon dioxide down to almost nothing.

I am very positive that with some of the eastern waters where the normal adjustment is below 6.0 pH that there is corrosion, in fact they have had some complaints but not such serious manifestations of red water as at Southern Pines and Asheboro. As a matter of fact I think that some superintendents have slightly red water in the mains frequently and have reached the point where they think there is no remedy for it and just have to put up with it and take it as a matter of course. I believe that this readjustment of the finished water up to a suitable hydrogen ion concentration value will prevent this corrosion and is an order of procedure well established.—G. E. Catlett, Raleigh, N. C.

Tool for Recovering Well Cylinder.—Another simple tool has been used several times for raising pipe out of a well when the pipe has been dropped. The farther down the end of the pipe, the more the patience required to enter the

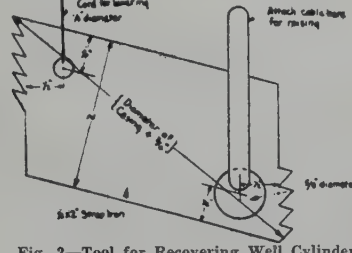


Fig. 2—Tool for Recovering Well Cylinder

tool, but once entered it will catch hold and bring out the pipe. It is made of ½-in.x2-in. strap iron in the shape shown in Fig. 2. The diagonal measurement "A" must be about ¾-in. longer than the diameter of the pipe to be raised. A cable of sufficient strength to raise the lost pipe is attached to the tool through a ring on the lower side and a strong cord is attached to another hole on the upper side. This string serves to hold the tool in a vertical position for entering the pipe. After the tool is properly entered, the pull is made with the cable, the string being allowed to remain slack. It is of course necessary to have the teeth as sharp as possible. The tool becomes wedged across the pipe and raises the pipe to the surface. If the water in the well does not stand too high or the lost pipe is not very far down, light can be reflected into the well and the tool easily entered. If this is impossible, the depth of the top of the lost pipe must be determined and the tool let down beyond this depth.

We always drill a small role in the inner casing of a well about 4 or 5 ft. below the ground surface. This allows the water to drain out of the pump in case it is shut down during freezing weather and no heat is provided. This drain is automatic and wastes very little water while the pump is running. This arrangement is a decided advantage where pumps are allowed to run all night unattended during freezing weather when the pump may stop and freeze up before morning.—Carl A. Heckmer, Salisbury, Md.

Repairing Cracked Mains.—Some years ago I had a leak reported on a 12-in. main. When we opened up on it we found that the spigot end of the pipe was cracked. The crack ran about 18 in. out of the bell. Rather than cut this section I used two clamps made of ¾-in. by 2-in. flat iron. These clamps were made in two sections, one-half circle in each section, with 3-in. lugs on the ends and 1-in. hole bored in each lug. The whole clamp is made so that it is a snug fit with about 2 in. clearance between the lugs when it is placed around the main. Use long threaded bolts through the holes in the lugs, drawing the clamp further away from the bell tight first, then tighten the next clamp. As you start to tighten the clamps, if you will take two light round pien hammers and lightly tap the pipe just on each side of the crack you stand a better chance of getting a good tight joint, as the vibrations of the hammer blows cause the ragged edges of the iron to seat together more evenly.

In case the crack happens to be in the body of the pipe and not at the end, you can do the same thing. Though it is better to start the two end clamps first, working gradually toward the center—that is, if it requires more than two clamps. The clamps should be spaced about 8 in. to 12 in. apart, depending upon how bad the crack is. If the crack is ragged and uneven there is no chance of making a fit. If the crack happens to have been caused by a blow from a pick and the pick stuck through the main, work the crack up the hole caused by the point of the pick and then put a heavy lead gasket over the hole and a clamp over the lead gasket and draw the clamp up tight. Of course you will get wet and all these cracks will happen in the winter time and at night, but then it is easier than to cut out a section and costs about one-fifth as much.—McKean Maffitt, Wilmington, N. C.

Reading, Billing and Collecting.—We use a postal card system and we read and bill every day. We have two meter readers that don't do anything else but read meters and re-read and check up and inspect. They read about 200 meters a day and in the evening they turn in their cards. The next morning a girl makes out those bills on a Burroughs billing machine using postal cards and the bills are mailed that afternoon. The bottom of the bill carries the notice to bring the bill when paying. If the bill is paid by check, there is a notice to detach the stub and forward with check. There is also a notice that the bill is now due and must be paid within ten days.

We send out 200 bills each working day of the week. We collect about 200 bills each day, so we have a constant flow of work. If a person comes in without the bill, we make them go to the second floor to get a duplicate. That means a person has got to walk up a flight of stairs. Very seldom do you find people coming in to pay their bill the second time without having the original bill which we sent out.

Recently we had to make some alterations to the first floor and we had to move everything to the second floor. We have had a lot of complaints about making people walk to the second floor to pay their bills—more complaints about that than anything we have done in the last nine years.

Instead of using sheets, we use the card system—6x8 in. ledger cards. The bill is made out from the original read-

ing of the meter reader. The bill that is prepared is recorded on the ledger cards.

At the end of ten days when these bills are not paid, the young lady takes the routes that were read ten days previous and goes through them and makes out a final notice. That is made in triplicate. A copy is mailed to the consumer. The government does not permit you to mail a dun on a postal card, so that notice has to go out first class. On this notice is the statement which is not exactly a threat, but almost so, that if the bill is not paid within five days the water service may be discontinued. We don't want to say it will be, because that is a direct threat. We allow them 48 hours after that five days, so if they should mail a check we will receive it. If a letter does go astray and we should turn the water off, we return the fee if the postmark is within the limit allowed.—J. E. Gibson, Charleston, S. C.

Joint Sleeve.—We installed a line of Universal pipe some time ago and the foreman in charge was a little skittish about the joints and had them pulled up hard and tight. About three years after installation trouble began to develop in every cold spell. We found that in taking out a broken section we were lucky if we got by without breaking at least five spigot ends—thus there was always 25 ft. of pipe that was wasted. That being too expensive, I had these flanged sleeves made and in case we have a Universal joint that leaks we put this around the joint, bolt it tight onto a lead gasket, yarn and pour the same as we would any other joint, and that is the end of our trouble. About a week ago we had a 6 in. B. & S. line to slump off the side of a hill and pulled a spigot so far out of the bell that you could stick a pencil into the joint. As it was impractical to straighten the line up just at that time, we tried one of these joint sleeves and it worked so well that for the time being we have left the line just as it was.—McKean Maffitt, Wilmington, N. C.

Turning on Water.—Our rule is almost universal that if a man is not an owner of the property he must make a deposit of at least $5. We pay interest on that deposit. We find that if a man moves, he is just as jealous of the $5 as he can be and he doesn't move until he comes down and gets that $5 back with interest.

If a meter lays idle for two weeks, we take it out. Of course, it costs us something to take a meter out but we bring it to the office, put it on the test table and if it tests all right, we simply put it back in stock to be used again. If for any reason it does not test satisfactorily or the meter inspector has reason to believe that the meter should be cleaned, the meter is then cleaned and put in good shape. We have found there is quite a saving in that because it overcomes the trouble of a plumber turning on the water and leaving it turned on.—J. E. Gibson, Charleston, S. C.

Plug for Testing New Mains.—By W. L. Weaklend, Superintendent of Water and Lights. Our city ordinances provide that an addition to the city shall be put to grade and have water and sewer mains installed before it is accepted by the city. We have had two blocks of 6 in. C. I. pipe put in to comply with this ordinance in the last few days.

Property owners pay all expenses for water services from the main to the property or house. Extra strong lead pipe

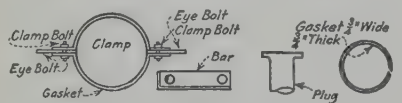


Fig. 3—Sketch of Plug

is laid to the curb stop, which is placed within 1 ft. of the side walk, in the parking.

In putting in the two blocks of the cast iron main we do not allow the contractor to cover up bells until the joints are tested out for leaks.

We test out every block and inasmuch as we do not put a valve every block we have to use a test plug. Heretofore we always had to either put in a plug with lead, the same as any other joint, or a plug that was supposed to screw out of the joint.

I very soon saw that this was not very practical so I had a clamp made to fit the bell of the pipe. I also had two eye bolts made so that you could put the bolt that holds the clamps together through the eye bolt when you put the clamp on the bell. I also had a bar made to go from one bolt to the other, this bar also had holes in it for the eye bolts to go through. The purpose of this bar is to go across the plug which is put in the ball. I made a gasket out of some packing that we use to pack our triplex pumps with. This gasket is soft and pliable so as to take up the pits and slight raises that may be either on the bell or plug.

The plug that I use is the style where the head of the plug goes in the bell. In installing this test plug you first put your clamp around the bell with the eye bolts in place, then you see that the bell is free of dirt or other particles before putting the gasket into the bell; then place gasket and see that the plug is free from frozen dirt, asphaltum or tar on the face that goes next to the gasket; then put plug into place against gasket, then put the cross bar across the plug with eye bolts; through same put nuts on eye bolts and tighten up.

This plug only takes about 5 minutes to put on and from 3 to 5 minutes to take off and saves the inconvenience of melting out the old style plug.—W. L. Weaklend.

Painting Hydrants.—Hydrants should be painted occasionally, to protect them and for the sake of appearance. We find that once a year is not too often to do so. The color scheme is a light gray barrel with a dark green top. The light gray barrel shows up very plainly at night. In the day time there is also a decided contrast against the green hedges and grass parkings which predominate in our area. The dark green top makes it easy to spot the hydrant when snow is on the ground and yet the green color blends with the landscape and is pleasing to the eye.—Carl A. Heckmer, Hyattsville, Md.

Hydrant Records.—Hydrants are inspected three times each year, in early fall, winter and spring. Flushing is done in the fall and spring but not in mid-winter because of the formation of ice in the streets. A record of the inspection, nature and cost of each repair is kept on a card system, but for quick reference we have originated an idea which has been highly commended by the Fire Underwriters' engineers. We use a map, made on a 600 ft. scale, mounted on wall board for this system. A push pin shows the location of each fire hydrant. The color of this pin denotes the condition of the hydrant, blue being used for a hydrant in good condition, black for a hydrant which is in need of minor repairs, but still operative in case of fire, and red for a hydrant which is entirely out of service. We, of course, make every effort to keep all blue pins on the map, but a red pin is rarely left on the map over night and then the local fire department is notified. When a hydrant is reported out of service, a glance at the map shows whether all the hydrants immediately around it are in good condition. As many different makes of hydrants were used on the several systems acquired by the Sanitary District, it is an advantage to know the make of hydrant before sending out a repair gang so the proper parts may be carried along. By using small round colored discs under the push pin we can determine at a glance the make of the hydrant, a different color of disc being used for each make of hydrant. Small celluloid flags are used to show the date of the last inspection in the various areas. The dates are written on the flags in ink and can be easily washed off and corrected with each subsequent inspection.—Carl A. Heckmer, Salisbury, Md.

Patching Cuts in Paved Streets.—In patching paved streets where there is a dense traffic and it would be inconvenient to leave the hole blocked off for some time while the concrete set up, I tried the following method: Tamp the hole until it is solid as you can make it. Make a mixture of concrete the same as usual only not so wet. Make it the consistency of stiff putty. Put this in the hole and tamp it hard. I mean hard, not just light taps. Tamp it until it is almost impossible to make an impression on it with the tamping iron. Put your top surface down on this tamped concrete. Bricks, sheet asphalt, Hastings asphalt blocks, Kentucky Rock Asphalt or any other kind of surfacing. Cover the finished surface with about 1 in. of loose sand and open it to traffic. Nothing short of a 10-ton load will affect it. There are about fifty such places here in Wilmington. It worked out so well that even on those streets where there is very little traffic we do the same thing. We never block off a paved street for the regulation ten days. Only just so long as it takes us to put in the material.—McKean Maffitt, Wilmington, N. C.

How to Beautify Grounds Surrounding a Water Works

The following simple landscape principles by Jas. D. Fowler were abstracted from *Municipal News and Water Works*:

One thing which has been greatly neglected around water works plants is the beautification of the surrounding grounds. It is a thought worthy of consideration by public officials, or any tax-paying citizen.

Why Water Works Grounds Should Be Beautiful.—Water works grounds should be beautified for psychological reasons if for no other. Beautiful things or surroundings suggest purity.

A water works is only one of the several utilities which should be given the beautification treatment such as will be outlined in this paper. Electric light plants, gas plants, ice plants and sewage disposal plants should be given equally as much attention.

The general opinion is, especially in the smaller towns, that to spend money for beautification is a waste of money, that the water will not be made any better thereby and that the revenue of the plant will not be increased. We may have to admit that there is no direct benefit derived but there surely is an indirect benefit. A well cared for and beautified water works plant is sure to be seen by someone and possibly many who in turn will tell others and the result will be advertisement for the town.

It may be that the city officials will say that there are no funds for such a purpose, but the real difficulty is with such officials that they have not been able to visualize and see the beauty in nature. It is wonderful and marvelous the progress which has been made in the manufacture and development of machinery but such is as of naught compared with the things of nature. When we see the seed planted in mother earth and it bursts forth into a beautiful flower or shrub then that is something to marvel about. When a little landscaping is done we are getting back closer to nature and the things that are beautiful.

Too often we find that a water works plant, especially those owned by a municipality, it is the business of everybody, hence nobody's business. The writer has observed generally, that privately owned plants are given more attention along beautification lines than are muncipal plants.

Chief Operator Not to Blame.—The chief operator of a plant cannot always be blamed for lack of attention along beautification lines and is ofttimes not recognized in his effort to accomplish something. When he applies for financial assistance the city council or authorities do not appreciate the value and necessity of such expenditure and he is turned down in his request. This disgusts the operator, he resigns and then is probably replaced by an incompetent man who will not worry them and who can be employed at a modest salary.

One who expects to accomplish something must realize that the road is not always smooth. He must have that sticktoitiveness and educate the public and more particularly the city authorities with whom he has to deal. He can do this by keeping his plant clean and on a small scale begin to beautify the grounds. He can get some of the citizens to visit the plant and appreciate what is being done and from then on enthusiasm and interest will grow and out of town friends will be invited to visit the plant.

Beautification a Separate Problem for Each Plant.—The landscape development is a distinct problem for each individual plant. The ideal way to proceed would be to employ a landscape architect to prepare plans and make suggestions for the improvement. This, of course, would require an outlay of cash and this, as has been pointed out, is very difficult to secure.

Also, as has been said, the work can be begun in a small way. It is not necessary that the entire work be done or anything elaborate be accomplished immediately. If you will stop for a moment and think what small job it would be to smooth off the rough places or slopes and sow some grass seed, or in southern sections, spot a few pieces of bermuda grass, you would not be long in starting a beautification program around your plant. Water is very necessary in an undertaking of this kind, but the subject we are dealing with being water works would indicate that water was no object.

General Plan of Development.—It is well for the operator who determines to accomplish something along this line to have in mind the following principles which will be outlined, and to prepare in his own way a general plan for the development which he can execute from time to time and gradually expand.

The operator should make a rough map showing the relative locations of the various features on the ground. He should secure sufficient information in regard to the levels to properly drain the grounds and, on this plan sketch out the various features to be added with their ultimate position. He should give general consideration to the grading, driveway, walks, shrubbery, planting, and on more elaborate plans, he would probably go into the matter of flower beds, garden furniture, seats and other features.

Driveways and Walks.—In laying out the general plan one of the first questions will be the driveway, provided the grounds are so situated as to require a driveway. The purpose of the driveway is ingress and egress. It should serve its purpose quickly and be as direct as possible; it is not in itself an ornament but is a utility. On large grounds, it may be one of the functions of the driveway to permit passage through the grounds for the purpose of viewing other features more distant. In such case it may be expanded over greater areas.

The width should be ample, but not excessive. The directions should always be simple and apparently direct. Unnecessary curves and turns are only awkward, not beautiful. The driveway should be located so as not to cut up lawn spaces unnecessarily but should be fitted to the topography and gracefully curve around the existing natural features. If there are no existing natural features, it may be necessary to design a planting of trees or shrubbery to give reason for the desired changes in direction . It is not proper to use a small flower bed, or a small architectural object, or other such things as they are too trival. The driveway should be from 9 to 10 ft. wide for a single drive, and from 16 to 18 ft. wide for a pass drive. A 12-ft. drive should never be used. It is too narrow for two vehicles to pass and unnecessarily wide for one. There is no beauty in paving surfaces; lawns are to be more desired than the barren driveway.

It will probably be unnecessary to speak of drainage, materials for construction and construction features such as excessive grades, etc., but they should be considered, of course, in a practical manner.

Walks and paths are designed and built on the same determining principles as driveways; there should be some reason for their being, as for instance, to lead to a gate, a door, a seat, or some other feature. The construction is also similar to driveways. On steep grades, steps can be worked in to advantage; also an opportunity to show originality on the design of butresses, walls, etc., is here given. Where a path is seldom used or where a solid walk threatens to cut through a lawn, stepping stones are desirable, set in so the lawn mower will pass over them.

Use of Shrubbery Beds.—Shrubbery beds are used to screen off undesirable views and angle points, border division features and for foliage effects, etc. Shrubbery beds should be shaped to conform to the purpose and location of the bed. The ground plan of the planting should show prominent points and deep bays. The extent of a particular section may be apparently increased by the appearance of distance made by a plantation bay. In planting, strive to get simple, broad effects instead of startling, unusual ones. It is better to secure more restful and peaceful results and impressions than unnatural effects.

Plan to plant in groups and masses rather than in spotting the lawn with individual shrubs. A lawn in which the shrubbery is spotted in individual specimens seems to be much smaller than the actual dimensions, while a lawn with an open center and the shrubbery grouped on the border will have just the opposite effect, and will give the effect of spaciousness. A single row of trees or shrubs for a screen is not so good as a broad mass planting. In planting a group do not arrange the plants in rows or tiers. It is a good plan to observe how Nature masses the shrubs by intermingling the various trees and shrubs. This does

not mean that the plants should be shuffled and placed in a haphazard fashion. Observe the natural groups and you will find character and pleasing effects. Nature enables sturdy plants and trees to stand out above the remainder. In planting in groups, individual plants scattered throughout the groups and separated from one another does not give a natural effect. There should be several of each kind of plants in a group and the groups should be blended into other groups.

Balance in Symmetry.—The human eye naturally seeks balance in symmetry. In Nature the idea of balance about some common center is evident. Do not take this suggestion too literally and duplicate individual shrubs about a common axis, but use shrubs of similar habits and similar positions, although not necessarily identical positions. It is not necessary that expensive nursery grown shrubbery be used. It is, of course, more desirable and convenient, if nursery stock could be secured, but very often it is possible to secure native shrubbery from the adjoining woods which, when properly transplanted and cared for, will respond and create some wonderful effects.

Since landscaping is more or less a sideline of mine, I will let you in on some of the secrets of the business. For instance, you are probably all familiar with the so-called buck bush which grows promiscuously in the woods. It is a very simple matter to transplant these successfully with practically no cost. However, when a landscape architect handles the buck bush for the client the name is changed to symphorycorpusresmorus and the cost of the plant is from 10 to 25 ct. each.

The introduction of some pointed pyramidal shrubs or trees, such as lombardy poplars, at salient points gives character and adds interest to an otherwise monotonous planting. Trees should be placed at desirable points for shade and to form vistas. Good judgment should be used in the planting of trees so that, as they grow, they will not interfere with the operation of the water works plant.

The Importance of the Lawn.—There is no feature of landscape planting which is more important to the successful beautification of property than a beautiful lawn. Its importance is seldom appreciated and too often the lawn is not properly considered. It is the foundation and background upon which the various features are placed to form the picture. It harmonizes and ties the various features together with pleasing contracts. A good lawn is similar to a well dressed person; it is not conspicuous unless deficient. Brown or unburnt spots or weedy patches attract attention to the lawn and minimize the effect of all other features. The lawn will respond readily to treatment and attention.

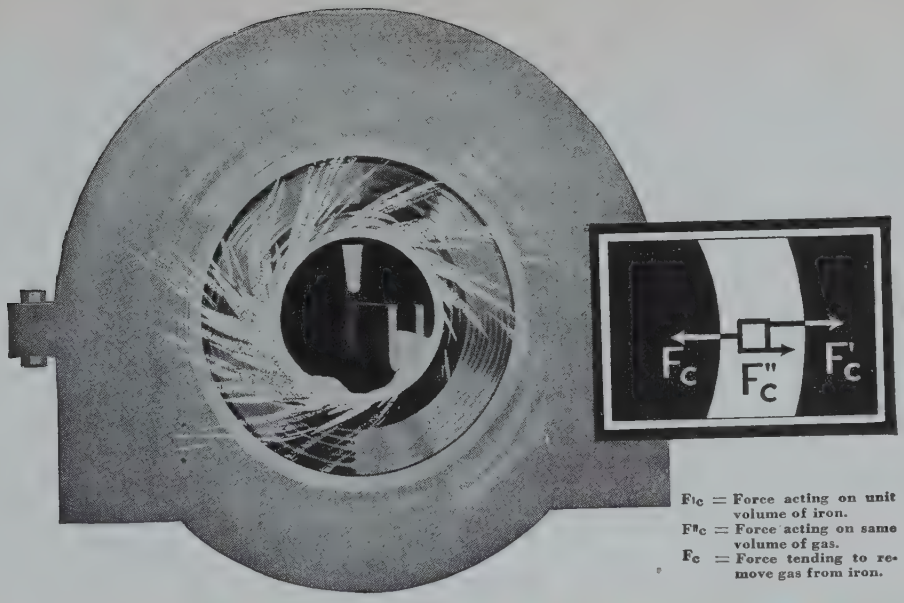
Too often a lawn is expected to grow on excavated clay and shale or on a thin layer of soil covering piles of rock and building debris. A properly prepared loam bed will repay many times the extra trouble necessary, when the drought comes late in the summer. The grading of the lawn, apparently is a very simple matter, but is very important to the final appearance.

The topography should be carefully studied and a contour of the lawn should form an integral part of the landscape. It should blend from one elevation to another without abrupt change. A perfectly level piece of lawn with informal and irregular surroundings is entirely out of place. Long, flowing, sloping lines should be maintained. This will also enable the lawn mower to be more easily operated and the lawn to be kept in better condition.

Location of Flower Beds.—It is poor practice to put flower beds or rose beds in a lawn in every conspicuous place. They should be placed along the edges of the shrubbery border in convenient protecting bays. The shrubbery forms a good background and a frame for the blooms, and the maintenance of the grass edges around the flower beds is reduced to a minimum.

Roses are beautiful when in bloom, but in other seasons they are an unsightly group of briers. The best place for roses is a separate area grouped in a rose garden, or along fence or trellis. Roses will do better when protected from strong winds than when set in an open lawn.

For the extensive and elaborate grounds other features may be worked into advantage. Seats conveniently placed are very interesting; pergolas, monuments and statuary all have their place and can be worked in from time to time.



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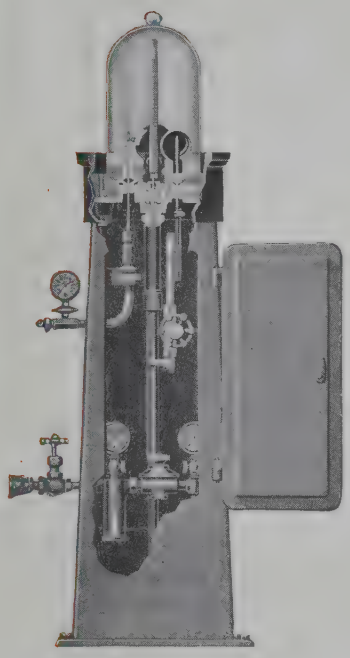

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